DRAFTING 10

ALBERTA DISTANCE LEARNING CENTRE

Drafting 10

Distance Learning

Alberta
EDUCATION

Drafting 10
Student Module
Lessons 1-20
Alberta Distance Learning Centre
ISBN No. 0-7741-0757-X

Purpose of the Course

For the student the Drafting 10 course has two main purposes:

1. to develop a skill in drafting; and
2. to develop an understanding of how to read and interpret blueprints.

Available Credits

The course may be taken for 3, 4, or 5 credits.

If you have registered for 3 credits, complete Lessons **1** to **12** only.

If you have registered for 4 credits, complete Lessons **1** to **16** only.

For the 5-credit course, **all 20** lessons are to be completed.

All the instructional material is contained in the lessons.

Supplies

Supplies the student **must** have:

1 T-square
°1 30° - 60° triangle
°1 45° triangle
°1 Drawing compass (for use with a pencil, preferably a compass which is part of a set of drafting instruments)
°1 Ruler graduated in millimetres, (if the student does not have a metric architect's scale)
°1 Pencil eraser (a clean, soft, pink eraser)
2 Pencils (one of these an H-type and the other a 4H-type)
1 Roll drafting tape (masking tape)
1 Drawing board (preferably 450 mm by 600 mm in size), if the student does not have a square and smooth desk top or table top to work on.

°These would be the **absolute** minimum needed for this course.

Optional but very useful:

1 Pair of dividers, preferably part of a set of drafting instruments
1 Architect's scale in metric size
1 Small piece of fairly fine sandpaper for sharpening pencil lead
1 Clean cloth or draftsman's erasing brush

You may use the order form on page iv of the introduction to purchase any of the above items if you wish.

Upon completion of the course you will be required to write a final test. Be sure to bring all essential supplies with you at that time.

NOTES: Extra drawing paper for the lesson exercises is at the back of this course.

All dimensions given in this course will be in millimetres (mm) unless otherwise stated.

How to do the Lessons

Read the material contained in each lesson. Complete each exercise in the space provided. Do the drawing problems on the sheets of paper provided with each lesson. Return to the Alberta Distance Learning Centre all completed exercises and all drawings in the lesson, along with a completed LESSON RECORD FORM.

Contents of the Course

How the Final Grading is Obtained

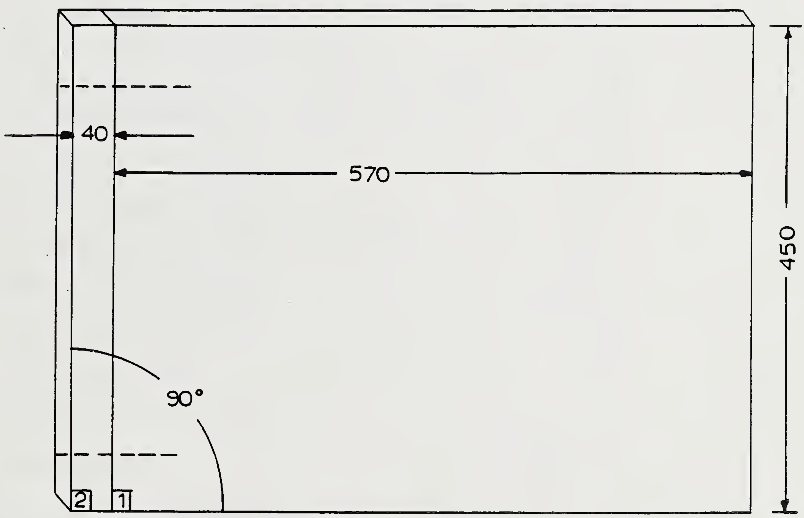
Your final mark in this course will be a 50-50 split between the mark you obtain on the final test and the average of all of your lesson gradings. However, if you score less than 50% on the final examination, your final mark in Drafting 10 will be based entirely on the final examination score.

Instructions for Making a Drawing Board

Since a professional drawing board is relatively expensive, drafting students may make their own drawing board for use in this course if they so desire. Plans for an inexpensive board are given below.

Materials Needed: (Purchase locally.)

1. Plywood — 5-ply, about 20 mm thick, 450 mm × 570 mm
2. Clear Spruce, boxwood or basswood 40 mm × 20 mm × 450 mm
3. Finishing nails 60 mm long plus glue and sandpaper



Saw and plane angles 1 and 2 to 90° exactly (use a good square to check this). Glue and nail the slide strip on the left side after the strip has been planed to size and has straight edges. Set in the heads of the finishing nails at least 3 mm before beginning to plane the edge square and smooth. Make sure to glue the slide strip to the board.

Using fine sandpaper sand with the grain to smooth the surface of the drawing board. With your fingers rub one very light coat of boiled linseed oil. Let the board dry two or three days before using.

NOTE: Do not plane into the nail heads. Set in the nails first.

ORDER FORM

(for Correspondence Students)

NOTE: Prices and product specifications are subject to change. In using this order form you should be prepared to pay any balance necessary, C.O.D. Do not send this form to the Alberta Distance Learning Centre.

Send this order form to the following address:

NorDraftReproductions Ltd.
10660-105 Street
Edmonton, Alberta
T5H 2W9
426-7820

Please send me the following supplies:

		Price	Amount
	One (1) 45° triangle, 200 mm No. S1450-8	$ 1.90	....
	One (1) 30°-60° triangle, 250 mm No. S1390-10	1.90	....
or			
	One (1) 30°-60° triangle small, 150 mm No. S1390-6	1.70	....
	One (1)600 mm T square, No. C24	10.83	....
	One (1) 150 mm plastic protractor No. P466	2.10	....
	One (1) scotch drafting tape ¾ inch × 10 yards No. 2300	1.60	....
	One (1) compass with extra pin for divider, No. 201	6.95	....
or			
	One (1) drafting set N. FCB33445	35.95	....
	One (1) architect's scale, Pic0 SI	5.73	....
	One (1) drawing board with metal edge No. DB117	38.25	....
	One (1) erasing shield No. 3298	0.65	....
	H and 4H pencils No. FCG 9000	each 0.79	....
	Sandpaper block No. FCM 51-1	0.65	....
	Draftsman's brush No. 2342	2.97	....
	One (1) French curve No. 1010-16	2.25	....

Enter in the amount column only those items you wish to order. **Net Total** $ ________

Make all money orders payable to NorDraft Reprographics Ltd.

Enclosed is a money order for $ ________ .

Name ____

Adress ____

____

____

ADVANCE NOTICE CONCERNING TESTING AND COURSE EVALUATION

1. In order to be recommended for credits in Drafting 10, you are required to write a supervised test set by the Alberta Distance Learning Centre before registration expires. A portion of the final mark will be based on your course work, as evaluated by a teacher of the Alberta Distance Learning Centre. If the final mark differs substantially from your year's work, the teacher will use discretion in balancing the composition of the marks in order to arrive at a fair assessment in the course. Appeal papers will be available to students who do not achieve a pass, and whose registration has not expired.

2. (a) Classroom students

Classroom students are those who are in attendance in school in Alberta and who are supplementing their school programs by taking one or more correspondence courses.

A student attending school does not submit an application for the final test. Test papers are sent automatically to the principal in January and June for writing before the end of the semester or at the end of August for writing during the first week of September for summer school students. At least **eleven satisfactory lessons (in the 3-credit course), fifteen satisfactory lessons (in the 4-credit course), or eighteen satisfactory lessons (in the 5-credit course)** must be received by the Alberta Distance Learning Centre before a test paper is mailed to the principal. All required lessons should be submitted before the test is written, since you will lose marks for the course work portion not done.

The principal is in charge of scheduling final tests and all questions about scheduling should be directed to the principal.

If a test is not written before the expiry date of registration, the course is considered incomplete for the school year which the student registered.

(b) Non-classroom students

Non-classroom students are those who are studying exclusively by correspondence and are not registered in any subjects in an Alberta classroom.

To obtain course credits, non-classroom students must complete all required lessons and write the final test before the expiry date of registration. Information about expiry dates is given in the Information Bulletin which a student receives before filing an application for a correspondence course.

The application for the final test is sent out when the corrected Lesson 6 (for the 3-credit course) or Lesson 14 (for the 4-credit or 5-credit course) is received by the Alberta Distance Learning Centre. The student submits the completed application with the next lesson sent in. The test is sent out after eleven graded lessons (in a 3-credit course), fifteen lessons (in a 4-credit course), or eighteen graded lessons (in a 5-credit course) have been received. All required lessons should be submitted before the test is written, since you will lose marks for the course work portion not submitted.

If a test is not written before registration expires, the course is considered incomplete for the school year during which the student was registered.

NOTE: For the purpose of writing final tests, students who live outside Alberta come under the same regulations as those in category (b).

PROBLEMS WITH DRAFTING 10?

You are about to start with Lesson 1. We wish you every success in this course and want to assure you that the services of the Alberta Distance Learning Centre are at your disposal. We are here to help you succeed. Should you encounter any problems with this course, do not hesitate to inform us.

Our address is:

Box 4000
Barrhead, Alberta
T0G 2P0

You can reach us by phone: 674-5333

If you live in any town or city that has a local RITE operator, you can call that number and ask to be connected to our school. The RITE number will be listed in your phone book under ''Government of Alberta''. If there is no RITE operator in your calling area, dial ''0'', ask for Zenith 22333 and then ask for the Alberta Distance Learning Centre.

It will be appreciated if you could give us your comments on this course. It is our desire to offer the best possible Drafting 10 course and your suggestions will help greatly. Indicate your suggestions or comments on the lesson record form under the ''student's questions'' section. Your responses will help up improve the course.

Best wishes!

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

FOR STUDENT USE ONLY

Date Lesson Submitted

Time Spent on Lesson

(If label is missing or incorrect)

File Number

Lesson Number

FOR SCHOOL USE ONLY

Assigned Teacher:

Lesson Grading:

Additional Grading E/R/P Code:

Mark:

Graded by:

Assignment Code:

Date Lesson Received:

Lesson Recorded

Student's Questions and Comments

Apply Lesson Label Here

Name

Address

Postal Code

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

Correspondence Teacher

St. Serv. 1-86

ALBERTA DISTANCE LEARNING CENTRE

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do not enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

USING THE DRAWING PENCIL AND ERASER TO MAKE SIMPLE SKETCHES

The Drawing Pencil

All drawing in drafting is first done with a pencil. Later you may learn to ink your drawings, but even an ink drawing is always drawn first in pencil. In this course all work is to be done in pencil. Ink drawings will not be accepted under any circumstances.

It is also important that only pencils with hard lead be used. Never do work in this course with a pencil whose lead is graded softer than H.

A capital letter appears at one end of every pencil. This letter indicates the blackness of the lead. Soft leads give a very black line with little pressure put on the pencil, while hard leads yield a grayer line. The letters indicate the range of hardness as shown below.

B	- soft
F	- medium soft
HB	- medium
H	- hard

Grades of 2B, 3B, 4B, etc., up to 6B are progressively softer than B. Grades of 2H, 3H, 4H, etc., up to 9H are progressively harder than H. Soft pencils are used by artists, not by draftsmen.

In this course you are to use pencils of two grades only: H and 4H. These pencils are readily available in Alberta stores. If your local store does not have them in stock ask the storekeeper to order some for you. Successful drafting can only be done with hard pencils.

DO ALL WORK IN THIS COURSE WITH 4H AND H PENCILS.

Do the preliminary work on all your drawings with the 4H pencil. You shall use mainly two weights of lines:

Light lines — these are drawn with the 4H pencil.

Heavy lines — these are ALSO drawn with the 4H pencil and then gone over or heavied up with the H pencil.

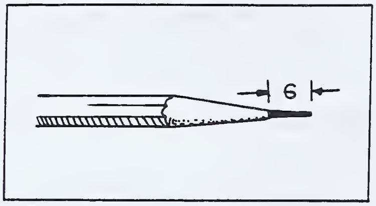
In other words, for our purposes the 4H pencil is our hard pencil, and the H pencil is our soft pencil.

Sharpening the Pencil

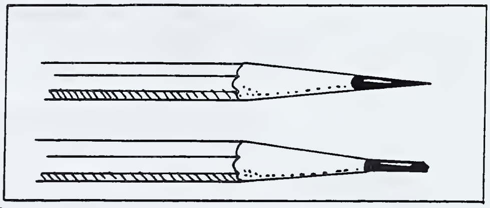
Sharpen the pencil at the end opposite the lettering so that the grade letter is not cut off as the pencil wears down.

The difference between the drawing work done by the layman and that done by the professional draftsman depends to a great extent on using exact procedures which meet the needs of this type of work. Most of these are easy to learn but are also easily overlooked. The procedure used for sharpening pencils is a typical example. A pencil sharpener is not used because it does not produce a good tip for drawing lines. Instead, the wood is trimmed off the pencil end with a pocket knife until 6 mm or more of lead is exposed. Do not cut the lead or scrape it with the knife. To sharpen the lead to a conical point rub it on a fine-sandpaper

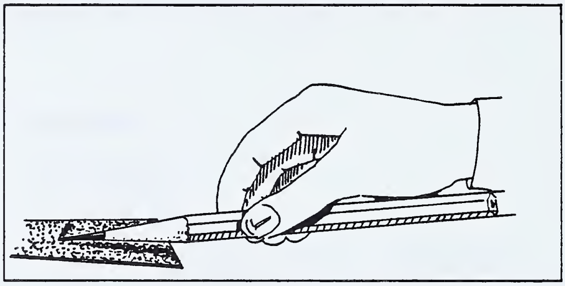
block, rolling the pencil between fingers and thumb while doing so. Do not keep the pencil sharpening equipment near the drawing board or instruments since this will result in graphite smears on your drawings. Blow on the pencil tip after sharpening, to remove graphite particles, and wash your hands before touching the drafting paper.



Trim the pencil so that 6 mm or more of lead is exposed.



Conical point on 4H pencil.



Roll and sharpen the point on a sandpaper pad.

Erasing

A good pencil eraser is always soft and pliable. Any pencil eraser will do provided it is fresh. The rubber dries out with age and the eraser must be replaced if it becomes stiff. An art-gum eraser is useful for erasing over a wide area, but is not essential for this course. NEVER use an ink eraser. It will destroy the surface of the paper.

In ordinary work one often blows off the particles left after erasing or even brushes them aside with the hand. Here again, correct technique makes the difference between layman and draftsman. NEVER rub your drawing paper with your hand or sleeve. This introduces dirt or grease onto the paper. ALWAYS use a clean rag or, best of all, a soft brush. (Special brushes are made for drafting use.)

Check List of Erasing Procedures

1. Draw all lines lightly until you are certain your work is correct.
2. Remove all instruments from the board before erasing.
3. Clean the eraser before using it, by rubbing it on a piece of scrap paper.
4. Hold the thumb and forefinger of one hand, in a position near the area to be erased, so that the drawing will not be torn or wrinkled while erasing with the other hand.
5. With a dust brush, sweep the entire drawing board free of all particles.

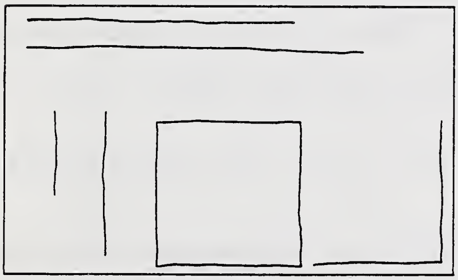
Sketching Straight Lines

Before one can make an accurate drawing a sketch is necessary. It is much quicker and more convenient to sketch freehand than to use instruments for drawing straight lines and circles. However, a sketch which does not show straight edges with reasonably straight lines

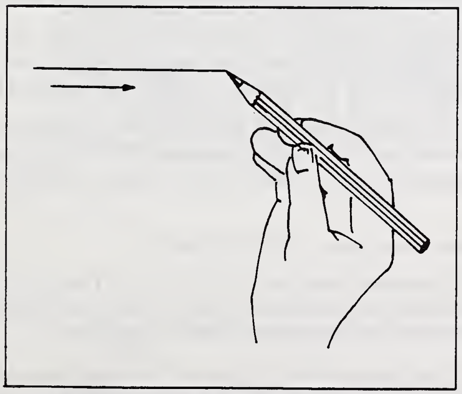
is of little use. To sketch good straight lines hold the pencil lightly about 50 mm from the point. Make a mental note of where you want to stop your line before you begin to draw. Then run your hand along, carrying the pencil in a single, fairly fast, relaxed movement along the paper to this point. Avoid lifting the pencil from the paper before you reach the end of the line. Draw each line with a SINGLE, clean stroke, not a succession of fuzzy strokes. To maintain the conical point on the pencil, occasionally rotate the pencil in your fingers as you sketch.

Check List of Sketching Procedures

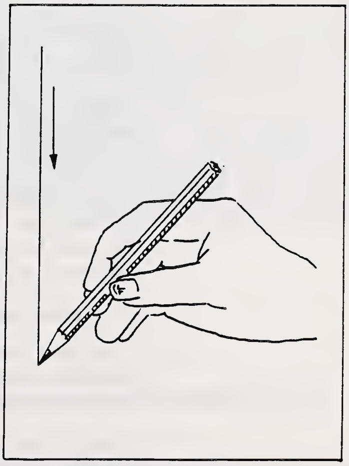
1. See that the pencil is kept sharpened to a long, cone-shaped point.
2. Hold the pencil lightly, 50 mm or more from the point.
3. Lightly locate the points between which the straight line is to be drawn. Start at one point and keep your eye on the other. Then draw your hand steadily across the paper. If the line is wavy, erase it and redraw it.
4. Use the eraser as little as possible. Try to get the line right the first time.
5. Sketch horizontal lines from left to right; vertical lines from the top downward. Lines at a slant are also sketched from the top downward.
6. Rotate the pencil in your fingers as you sketch.



Sketched lines should meet squarely.



Sketch horizontal lines from left to right.



Sketch vertical lines from the top downward.

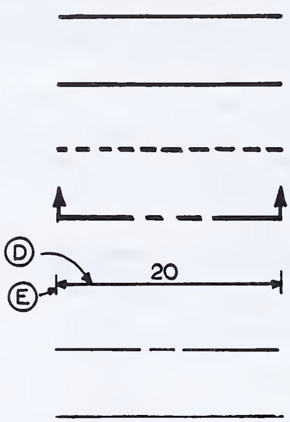
Lines Used in Drafting

We shall use three weights of line in this course:

1. Light Lines — drawn with the 4H pencil

2. Heavy Lines — these are also drawn with the 4H pencil but afterwards they are heavied up by going over them with the H pencil with a firm but NOT too heavy pressure.
   CAUTION: Heavy lines should never be thick lines. Any dense, black, thick line will smear the paper.

3. Construction and guidelines — these are drawn with the 4H pencil as lightly as possible. They are not intended to show on the finished drawing so they are drawn so lightly they will just be visible to the draftsman, and they will not have to be erased. If a drawing is later gone over in ink these lines are not inked in. After inking they are erased. But on pencil drawings they are NOT erased.



Border lines — heavy.

Object edge lines — heavy.

Hidden edge lines — heavy.

Cutting plane lines — heavy.

Dimension and extension lines — light.

Center lines — light.

Construction and guidelines — very light.

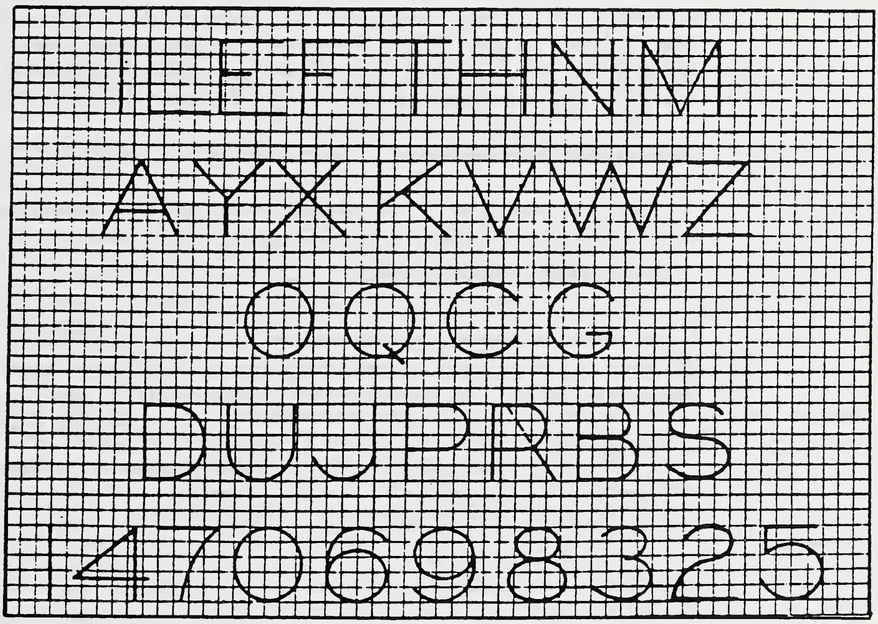
Check List of Types of Lines and How to Draw Them

1. Border lines: Lay them out with a 4H pencil. Heavy up the lines with the H pencil.
2. Object edge lines: These are drawn in the same way as border lines.
3. Hidden edge lines: Use a 4H pencil to draw and then heavy up the lines with an H pencil. The dashes should be about 3 mm long separated by 2 mm spaces. This spacing may be judged by eye. How these lines are used will be discussed later in this lesson.
4. Cutting plane lines: The long dashes are 20 to 40 mm long and the two short dashes between each long one are each 3 mm long separated by 1 mm spaces. What these lines are used for will be discussed later. Draw the lines with a 4H pencil and heavy them up with an H pencil.
5. Dimension lines are light lines made with a 4H pencil.
6. Extension lines are light strokes made with a 4H pencil. They are short lines which tell to which part of the object the dimension refers. They lead from a point about 1 mm from the view and extend about 2 mm beyond the arrowhead.
7. Centre lines are light lines made with a 4H pencil. The long dashes should be of uniform length, 20 to 40 mm long, and the short dashes should be 3 mm long. The spaces between the long and short dashes should be 2 mm. These lengths may be varied depending on the size of drawing. Centre lines are used to locate the centres of circles and the axes of symmetrical parts.
8. Construction and guidelines: These lines are made as light as possible by using hardly any pressure on the 4H pencil. The use of construction lines will be discussed and shown later in this lesson. Guidelines are used for lettering. These lines should be invisible when viewed at arm's length.

Lettering

Working drawings contain a considerable amount of words. These words include titles, scale indications, instructions on how to make holes and finish surfaces, etc. All lettering is done in the capital or uppercase alphabet, A, B, C, D, E etc. The lowercase letters a, b, c, d, e, etc. are **NEVER** used.

A finished drawing is called a plate. Most of the lettering you shall do on drafting plates will be 3 mm high. However titles of the plates will be 5 mm high. To start out with we shall ask you to outline much larger letters to enable you to note the details of their form and proportions more closely. This will be done on Exercise 5 at the end of this lesson. Study the lettering display below and note the following five points before proceeding onto the "Numerals" section of this lesson.



1. (a) The vertical letters in the first row are made up mainly of horizontal and vertical strokes.

   (b) Most letters are four units wide, but the base of E is slightly longer than the top; the top of T is 4½ units; H is a little wider than 4 units; M is 5 units wide.

2. (a) The letters in the second row consist mainly of diagonal strokes.

   (b) A is 5 units wide; X, K and Z are wider at the base than at the top; W is 8 units wide.

3. The letters in the third row are made up mainly of curved strokes. These curves are ellipses, not circles. E.g. O is not a circle ○ since it is higher than it is wide.

4. (a) The letters in the fourth row are a combination of straight strokes and curves.
   (b) Note that R, B and S are wider in the lower portion than the upper.

5. The numerals 8, 3, 2 and 5 are wider in the lower portion than the upper.

The reason several of the characters are wider at the base is so that they will not look top-heavy but give a feeling of stability.

Numerals

Lettering in drafting refers to drawing both letters and numerals. All lettering in drafting is done by first drawing very light guidelines. A pair of these lines is used to line up the top and bottom of all letters and numerals. The shape of each character should be uniform each time it is repeated and there is a set style for forming each which you should adopt. There are formal rules for making the strokes but you can probably arrive at your own system which will enable you to reproduce the desired style for each character. We shall now point out the main features of each character as you should draw it. To begin with, we shall show each numeral placed between guidelines 4 mm apart. Note that guidelines are VERY light. Use a 4H pencil for guidelines. Do your lettering with an H pencil. Beside each example, draw a succession of copies of the numeral to fill out the line.

Repeat each numeral about 10 times to the end of the line.

1 1

A single, straight upright stroke.

2 2

The upper portion is balanced over the base which is the widest portion.

3 3

Lower loop larger than upper. Do not use the 3 style as this resembles 5 too closely.

4 4

Draw the ∠ portion first, then add the | stroke. Keep the – stroke well below the middle height.

5 5

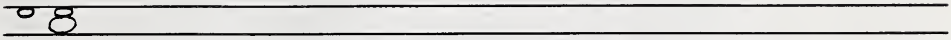
Draw the 5 first, then add the short bar at the top. Avoid 5 or 5 or 5.

6 6

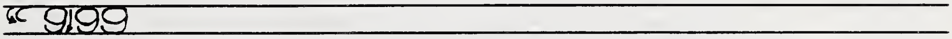
Note the 3 strokes. Reverse direction with each stroke. Avoid 6 .

7 7

Avoid 7.



Draw two ellipses, one under the other. Avoid  or .



Avoid .

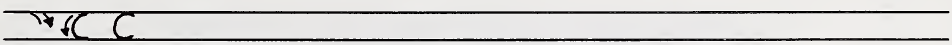
Draw zero in two strokes. It is an ellipse, not a circle.

Letters

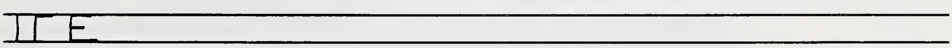
We shall note the features of each of the letters as we did the numerals. Again, complete each line with about ten copies of the letter. Note the individual steps in forming each letter.

Base is as wide as height. Avoid .

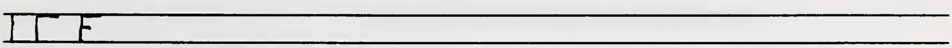
Avoid .



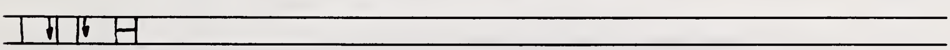
The two strokes are in opposite directions to avoid a tilted letter.



Avoid .



Avoid .



Avoid .

I

Avoid I. There are NO serifs on drafting letters.
The letter "i" and numeral one are the same. Serifs:

J

K

Avoid K K.

L

M

N

O

P

Avoid P.

Q

R

Avoid R R.

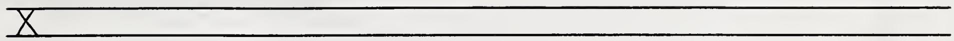
S

T

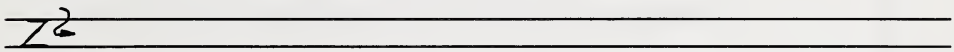
U

V

W



Avoid X.

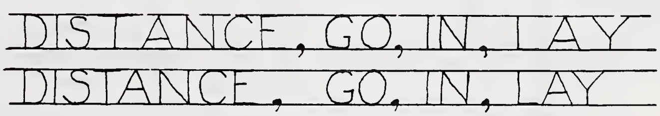


Avoid Z.

Spacing Letters and Words

It is a contradictory fact that if the letters in a word are each spaced an equal distance apart, they will NOT appear that way to the eye. Study the example below.

The distance from the extreme right end of each letter to the extreme left end of the next letter is equal in each case but the I and A in "distance" appear too far from the letters beside them. The spacing in "go" seems wider than in "in" and the Y in "lay" seems to be off by itself. The fact is that for letters to appear evenly spaced it is the areas of the spaces between the letters that should appear equal, not the end-to-end distances. Thus letters with curved sides are placed closer to one another than the average spacing, as are letters with slanting sides. Compare the two lines below:



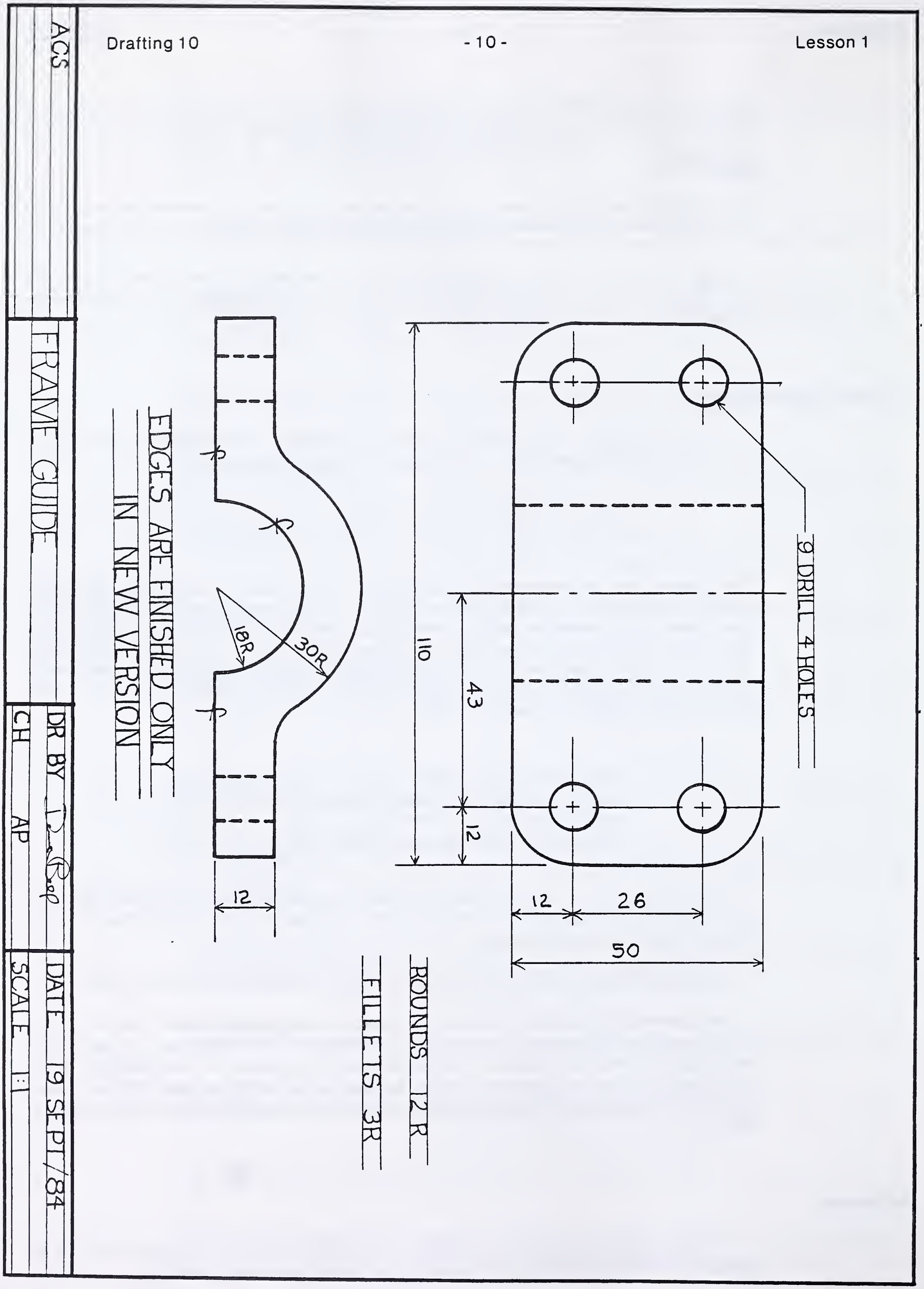
Rather than worry with hard and fast rules for spacing every pair of letters that may come together, you can use your own judgment in spacing to try to get the letters in each word so they look uniformly spaced.

Spacing between words should be at least as wide as a standard letter, such as H or N.

All lettering on drawings should be done between ruled guidelines even if only one short word is involved. Dimension numerals should all be the same height. You may be able to accomplish this without guidelines but if not, don't be reluctant to rule guidelines even though only one numeral may be required. See that all guidelines are very light and made with a very sharp pencil. Do not attempt to erase them from a finished drawing if pencil is used.

An Example

On the following page, you will find an example of a drawing that has lettering on it. Study it carefully and see how what we have been discussing has been applied.


ACS
FRAME GUIDE
DR BY
CH AP
DATE 19 SEPT/84
SCALE 1:1
EDGES ARE FINISHED ONLY
IN NEW VERSION
18R
30R
12
110
43
12
9 DRILL 4 HOLES
12
26
50
ROUNDS 12 R
FILLETS 3R

EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Selecting and Sharpening a Drawing Pencil

In questions 1, 2, and 3 answer "True" or "False" in the blank following the sentence.

1. The pencil should not be sharpened on the lettered end because the letter helps in selecting the proper pencil after the pencils have been sharpened. ____________

2. If one cuts the lead with a knife, the lead, being brittle, is quite likely to break. ________

3. A fine grade of sandpaper should be used for sharpening. ____________

4. Why should you sharpen the pencil away from your drawing?

   ____

   ____

Fill in each blank with the correct letter.

5. Soft pencils are lettered with ____________ and a number on the end while hard pencils are lettered with ____________ and a number on the end.

Fill in the blanks.

6. Pencils used in drafting are ____________ while those used by artists are ____________.

EXERCISE 2: Erasing

Answer "True" or "False."

1. If one's hand is used instead of a cloth or brush for wiping away particles left from erasing, the paper will become dirty due to grease and moisture from the skin.

   ____

2. An ink eraser will destroy the smooth surface of the paper even though it erases the line quickly. ____________

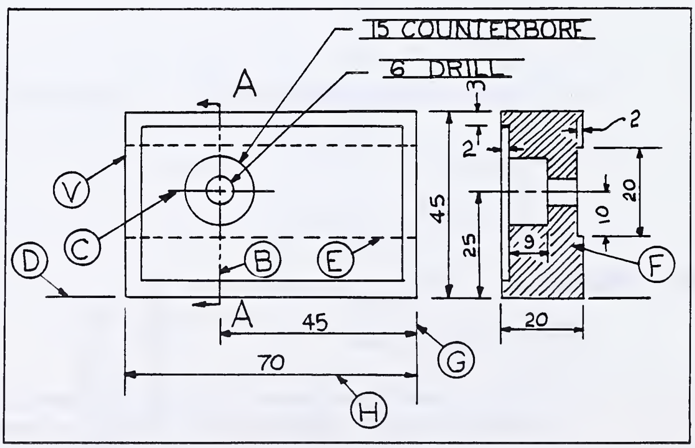
EXERCISE 3: Sketching Straight Lines

In the space below, use an H pencil to draw six examples each of

1. horizontal lines,
2. vertical lines,
3. squares,
4. L shapes.

EXERCISE 4: Conventional Lines of a Working Drawing

1. Match the names of the lines shown on page 4 with the lines marked with letters in the drawing below. "V" and "F" are done as examples.



Working drawing of a jig.

V — Object edge line

B —

C —

D —

E —

F — Cross hatching

G —

H —

2. The line that shows where a measurement stops is: (Underline the correct words.)

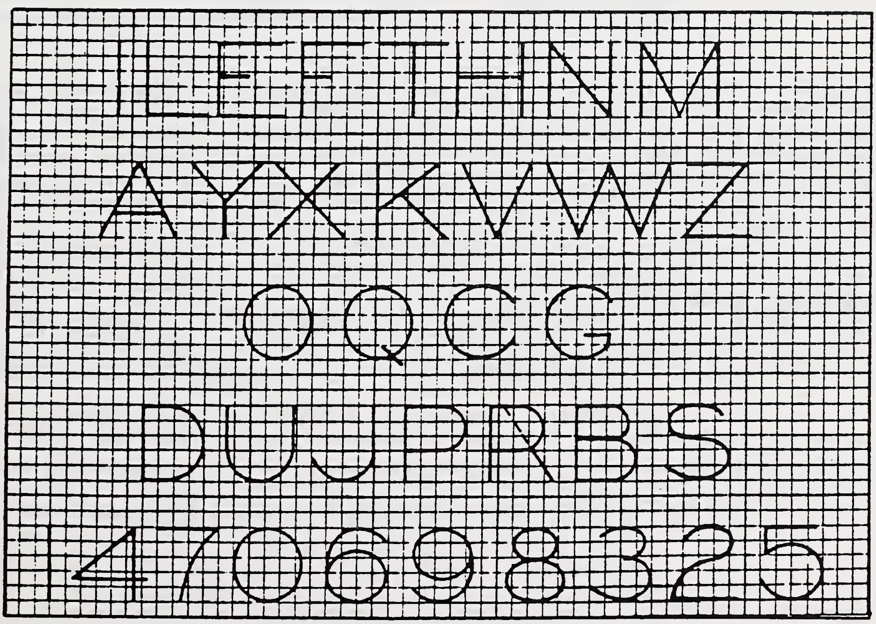
   (a) a section line,
   (b) a parallel line,
   (c) an extension line,
   (d) a visible outline,
   (e) a heavy line.

3. In the spaces below, draw an example of a:

   (a) heavy line
   (b) cutting plane line
   (c) dimension line
   (d) center line
   (e) construction line
   (f) hidden edge line

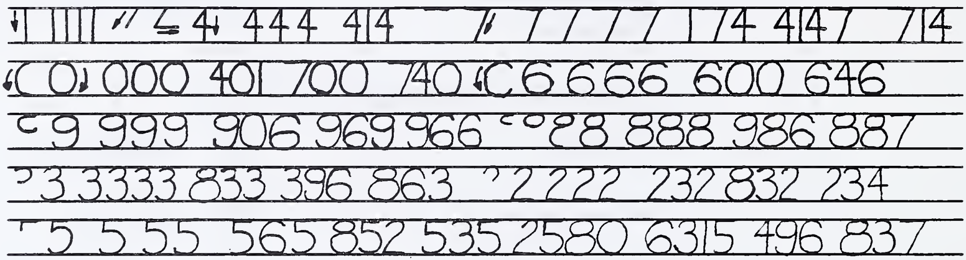
EXERCISE 5: Lettering

Copy the lettering below on the squared paper provided at the back of this lesson. Be sure to draw all lines **FREE-HAND** as instruments are never used in lettering except to draw guidelines. Note carefully the spacing of the width and height of each letter. See that the separation between letters is the same as shown below. Use an H pencil for lettering.



EXERCISE 6: Drawing Numerals

Copy the following numerals in the blank lines below.



EXERCISE 7: Making Letters

Fill in the blanks.

1. Some letters are made wider at the bottom to give an appearance of ______________.

2. The letter which is similar to E is ______. To X ______. To V ______. To C ______.

   To U ______.

3. What letters are similar to Q? ______________________________

   To R? ______________________________

EXERCISE 8: Practicing Letters

Copy the following letters on the blank lines below each section.

IIII I L LLL I L L E E E E EEL ILL I L F FFF IF
I I T T FELT TEE I I H HHH HEFT HEFT
I N N NNN NINTH TENTH I I M M MMM MINE
A A AAA MAIN MEAN Y Y YYY YALE
X XXX AXLE MAXIM K KKK MAKE
V VALVE V W W WWW WAVE WAXY
Z Z ZZZ MIZZEN MAZE A NEAT TITLE

C O OOOO ZOOM C O Q C CCC CHECK
C G GGG GONG GOGGLE I D DDD ADD
U U UUU GAUGE GAUZE J JJJ JOINT JIG
P PPP PIPE PAD PLUG P R RRR RACE
B BBB BABBITT S S SSSS SESSION
6 BEARINGS NUMBER 8436079 DRAWING A-25
PUBLIC SCHOOLS LETTERED BY

EXERCISE 9: Spacing Between Letters and Words

Copy the following letters and words on the 3 mm blank lines below.

FINE FILE METAL FILAMENT WAX FILLET MANY A KINK
KEYWAY LIMIT LOCATION OF OIL HOLE CONNECTING LINK
CHUCK MOUNTING HIGH QUALITY ALUMINUM JOURNAL BOX
MOTOR GENERATOR DADO JOINT DOUBLE-HUNG WINDOW
POPPET VALVES PISTON RINGS 120 INCH WHEEL BASE
BRONZE BEARINGS AIRPLANES ZOOM IN THE SKY
FULL VACUUM SYSTEM EQUIPPED WITH AMPLIFIERS
PUBLIC SCHOOLS INDUSTRIAL ARTS DEPARTMENT
SCALE: FULL SIZE DRAWING A-425 9-10-1938

END OF LESSON 1

QUESTIONNAIRE FOR DRAFTING 10

Please fill this in and send it with your first lesson.

Name ______________________ File No. ______________________

Address ______________________ Home Phone No. ______________________

____

Postal Code ______________________ Age ______________________

School Attended ______________________ School Phone No. ______________________

Welcome to Drafting 10. We hope that you will enjoy this course and find it informative and useful. Please complete the following, as this information will help your teacher when writing to you as an individual.

1. Why are you taking this course? ______________________

2. What do you already know about Drafting? ______________________

3. What kind of equipment and work space do you have available to do the drawings in Drafting 10?

4. How good are you with math? If you have difficulties, please state what they are, and also what math courses you have taken and what marks you have obtained.

5. What do you know about the subject of study? Do you have any difficulty studying? If so, what problems do you have studying?

6. Is there anything you would like to say before starting this course?

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

FOR STUDENT USE ONLY

Date Lesson Submitted ____________

Time Spent on Lesson ____________

(If label is missing or incorrect)

File Number ____________

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received: ________

Lesson Recorded ________

Student's Questions and Comments

Apply Lesson Label Here

Name ________

Address ________

Postal Code ________

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____

Correspondence Teacher

St. Serv. 1-86

ALBERTA DISTANCE LEARNING CENTRE

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do not enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

USING THE DRAWING INSTRUMENTS PLUS DIMENSIONING

Use of the Drawing Board and T Square

All drawing, except sketching, should if possible be done on the drawing board. The T square and drawing board together provide the means by which all horizontal and vertical lines are kept parallel with one another and with the edges of the paper. Your T square is a precision instrument whose head is exactly at right angles to the blade, and whose blade is as nearly straight as quality will permit. On the other hand, the sides of the drawing board may be not so precisely square. Therefore, if the head of the T square is switched over from one side of the board to the other, the lines drawn may not be truly parallel. Make a habit of always placing the head of the T square against one side of the drawing board only. This should be the left side, but if you are left-handed, you would use the right side. In either case always use the same side. Every time you use your instruments, make sure you first wipe the board and T square free of dust.

Fastening Drawing Paper on the Drawing Board

Use the drawing paper supplied with the lessons. If your board has a surface which is at all rough it is a good idea to first place a layer or two of smooth paper over the surface of the board. Attach this lining paper with masking tape at the top.

You would now want to place the drawing paper on the board so that:

1. it is perfectly flat when attached in place; and
2. it is lined up so that the drawing will appear straight on the page.

This is another of those operations which may seem to be so simple that no explanation is required. But unless the correct method is followed, the paper will not lie flat and square on the board and trouble will result when using the T square.

The edges of the paper may not be cut exactly square so line up the top edge and disregard any discrepancies in the others. Proceed as follows, after wiping board and T square free of dust. (Wipe the top edge of the T square to remove lead particles.)

1. Place the sheet in the upper left portion of the drawing board about 150 mm from the left edge and 100 or 125 mm below the top. With the paper in this region you will have arm freedom, and the head of the T square, being close at hand, can be readily kept firmly against the edge of the board.

2. Fasten the upper-left corner of the paper only. The best way to do this is to use a small piece of masking tape about 12 × 20 mm in size. Do not use cellophane tape as it cannot be removed from the paper cleanly.

3. With the head of the T square held firmly against the edge of the board, line the top edge of the paper with the upper edge of the T square.

4. With one hand, hold the paper firmly in position. With the other hand, slide the T square down toward the centre of the sheet. Hold it firmly while changing hands to make one hand free.

5. With the palm of the hand, stroke the paper snugly to the board working from the upper-left corner to the lower-right corner. Fasten the lower-right corner.

6. Smooth the paper firmly toward the upper-right corner and fasten.

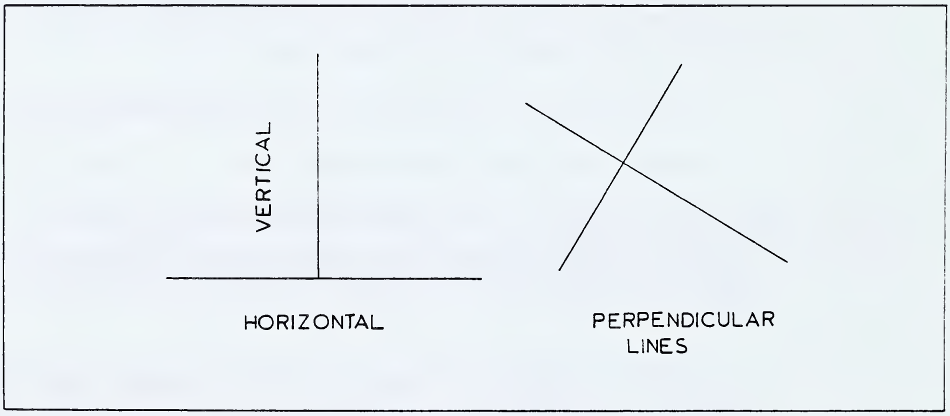
7. Check to see that the upper edge of the paper still lines up with the T square. If it does not line up then repeat the procedure.

8. Stroke the paper from the centre toward the lower-left corner and fasten.

Drawing Horizontal and Vertical Lines

Horizontal lines are lines that run from side to side across the paper.

Vertical lines lie up and down on the paper.



Vertical and horizontal lines meet each other at **right angles**. Lines which meet at right angles are said to be **perpendicular** to each other.

Horizontal lines are drawn using the UPPER edge of the T square. The head of the T square is always held firmly against the same edge of the drawing board. The place where the line is to be drawn is marked with a light horizontal dash. Proceed as follows:

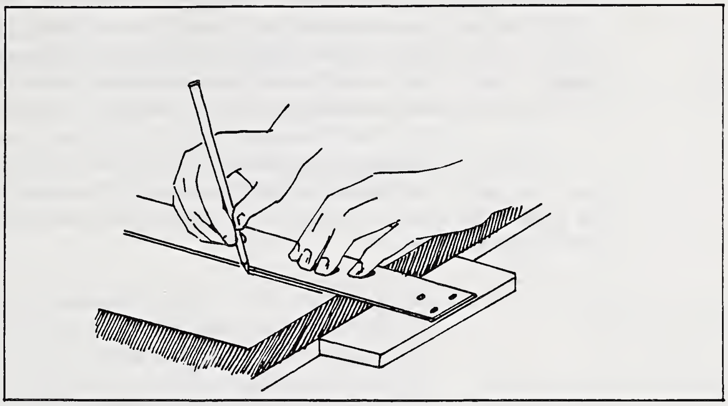
1. Place the pencil point on this dash.

2. Slide the T square up to the pencil point.

3. Draw the line from left to right, sliding the fingers along the blade of the T square as you draw.

NOTE: The pencil is placed in position on the dash first and then the T square is brought up to the pencil. Otherwise, if the reverse procedure were used, the exact allowance for the pencil width would not be made.

4. Hold the pencil so it is tipped in the direction that the hand moves and slightly outward as shown below. The point of the pencil must be against the blade as it touches the paper. Keep the pencil in the same position throughout to make sure that the line will be perfectly straight.

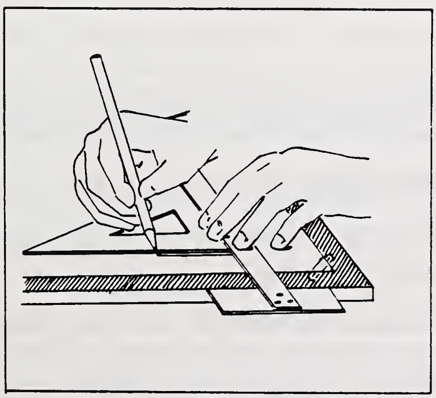


Drawing a Horizontal Line

5. Apply uniform pressure and roll the pencil slightly between the thumb and fingers as the line is drawn.

6. Do **NOT** track the pencil back and forth.

To draw vertical lines, proceed as follows:



Drawing a Vertical Line

1. Use the triangle along with the T square.

2. Place the T square so that the blade is below the line to be drawn.

3. Hold the pencil point on the vertical dash which marks the position of the vertical line.

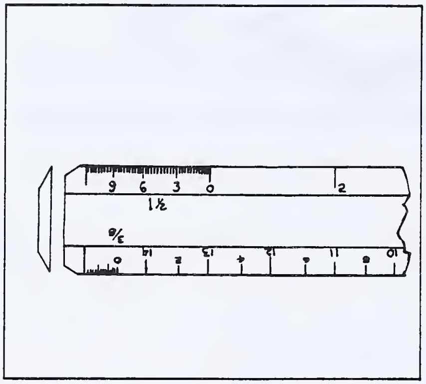
4. Keep one of the perpendicular sides of the triangle flush with the top of the T square blade and slide the triangle along until it touches the pencil point.

5. Draw the line from a point near the T square up toward the top of the triangle letting the fingers slide along the triangle. Use the other hand to keep the triangle snug against the T square, and the T square head snug against the side of the drawing board.

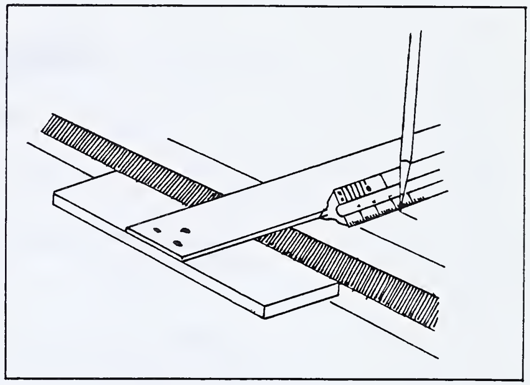
Locating Lines with a Pencil

The location of any particular line will usually have to be found by measuring. Suppose we want to draw a horizontal line 25 mm down from the top of the drawing paper. ① Place T square and triangle on the paper as previously instructed. ② Lay your scale measure along the vertical edge of the triangle. ③ Place the point of the pencil at the mark on the scale which is 25 mm from the paper's edge and draw a short, light, HORIZONTAL dash. The dash should be horizontal so that it will become part of the horizontal line when it is drawn. Do not make a heavy dot or an X since your measuring marks will stick out from the finished drawing. Measurement marks for vertical lines should be short vertical strokes.

The type of measuring scale used should be one which is bevelled so that the scale marks meet the surface of the paper. Any thickness of material between the scale indications and the paper will result in inaccurate measurements. An architect's scale or engineer's scale is best for the purpose.



Bevelled Scale



Triangular scale being used to make a short, light dash to indicate position of a vertical line.

Steps in Making A Working Drawing

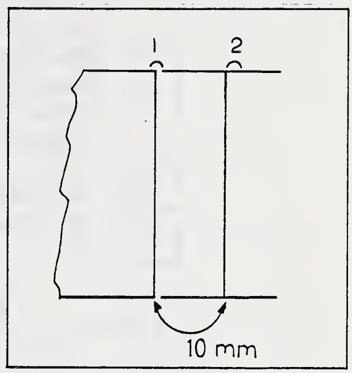
1. The paper is fastened to the drawing board with the long side horizontal. The method used to ensure that the paper lies flat was stated at the beginning of this lesson.
2. The necessary measurements are made to locate the lines which will be drawn.
3. The outlines of the object in each view are drawn using the measurements and construction lines explained in Lesson 1.
4. Space is provided between the views to allow for the insertion of all necessary dimensions.
5. The dimensions are inserted. All the drawing has so far been done with a 4H pencil.
6. The object lines (only) are heavied up with an H pencil.

When you make finished plates of working drawings, the paper will be first ruled with proper border and title strips, but this step is omitted in the present lesson.

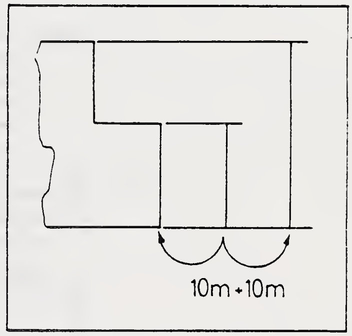
Dimensioning a Working Drawing

We shall now discuss dimensioning so that you will know how to space out the lines of working drawings so that the dimensions can be inserted in their correct places.

1. After blocking in the views, make the extension lines distinct using a 4H pencil. Many of them will lie on top of construction or projection lines so they can be shown by heavying up a portion of the projection line slightly with the 4H pencil. Start each extension line 1 mm from the object edge line and make it long enough to extend 2 mm beyond the dimension lines when drawn.



2. Place the dimension 10 mm from the object. (Never crowd the dimensions against the side of the object.) If there is more than one dimension, place them each, 10 mm apart. Uniform placing of dimension lines not only makes the drawing look better, but makes it more convenient to read.



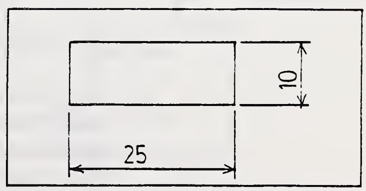
3. With a 4H pencil draw each dimension line so it starts and stops **EXACTLY** at the extension line.

4. Make neat arrowheads at each end of a dimension line, placing them so the points are exactly at the extension lines. (In the next section we shall give you instructions on how to draw arrowheads.)

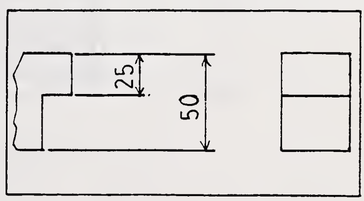
5. Make the figures for the whole numbers 3 mm high. Fractions are not used with SI.

6. The dimension figures refer to the size of the finished object, **NOT** to the drawing lengths. If all dimensions are in the same units, do not include the unit with the dimension figure. In this course all dimensions are, for the most part, in millimetres so just use the numbers and **OMIT** the "mm."

7. The figures for horizontal dimensions should read from the bottom of the drawing: e.g. **25** . The figures for vertical dimensions should read from the right side: e.g. **10** .



8. Keep dimensions **OUTSIDE** the object whenever possible. Sometimes this cannot be done without long extension lines, in which case dimensions may be placed within the object.

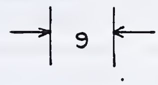


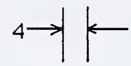
9. Place dimensions **BETWEEN** views whenever two views can be dimensioned with one line, but apply each dimension to one view.

10. Give a dimension of a single part **ONLY ONCE** even though that part appears in several views.

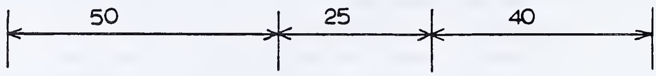
11. When there are several short and long dimensions together, place the short ones next to the view and the longer ones farther out so that extension lines do not cross dimension lines.

12. When a space is too small to place dimension lines between the extension lines, place short dimension lines outside of the extension lines. The figure can be placed inside the extension lines if there is enough space or it can be outside of the extension lines if the space between is too small for a figure.



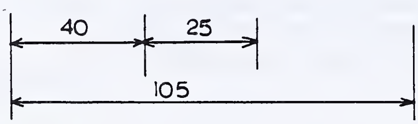


13. When there are several dimensions in a row, the dimension lines should form a single line. Dimensions are placed slightly above the dimension line, not on the line itself.

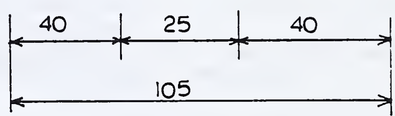


NOTE: There will often be several object and extension lines in line with one another. Try to anticipate this and draw all of them with a single setting of the T square, or triangle and T square in the case of vertical lines. There is no harm in drawing a single long construction line very lightly and then going over the portions of this which are required for object edge lines and extension lines.

14. When a length is broken down into parts, do not duplicate a dimension by dimensioning all the parts **AND** the total length.



RECOMMENDED



AVOID

NOTE: Always give the total length instead of one of the smaller dimensions.

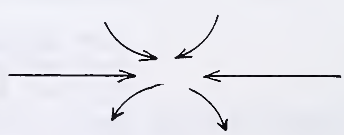
Arrowheads

1. Make arrowheads with a 4H pencil.

2. The arrowhead should be very slender and the sides should be graceful curves. Do not make the arrowheads too blunt. The approximate sizes are shown in the drawing, but these may vary to suit the space and in accordance with your own individual styling. But do not shade in the space between their sides. Any solid pencil shading tends to smudge.

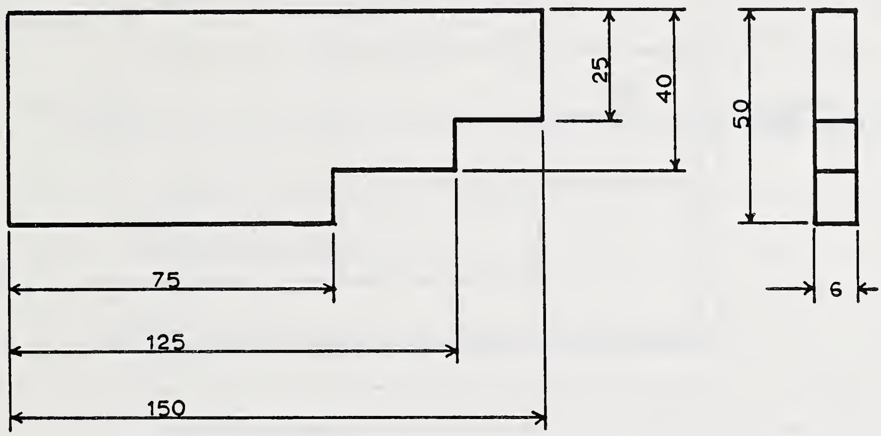
3. The two curves are made with a single stroke; from outer end to point and back to the other outer end.

Arrowhead

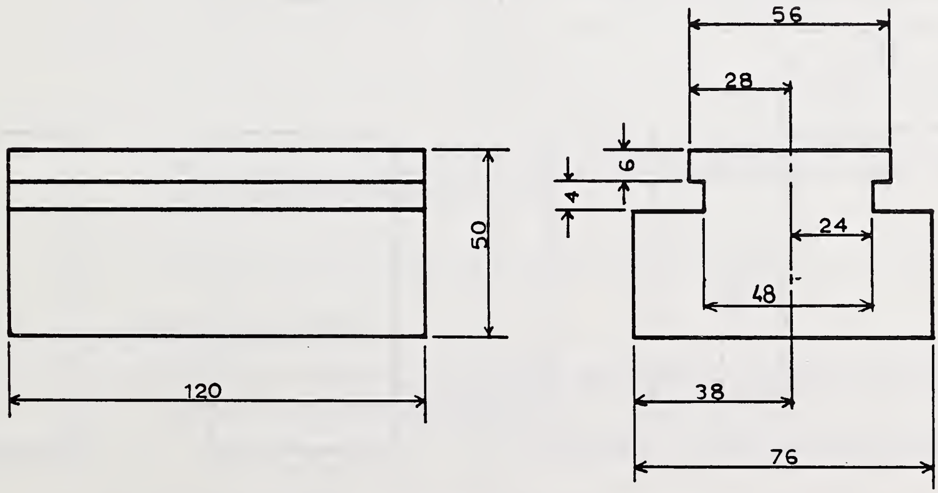


Directions of pencil strokes

Two Examples of Properly Dimensioned Drawings (NOTE: Allow a 10 mm space between dimensions.)

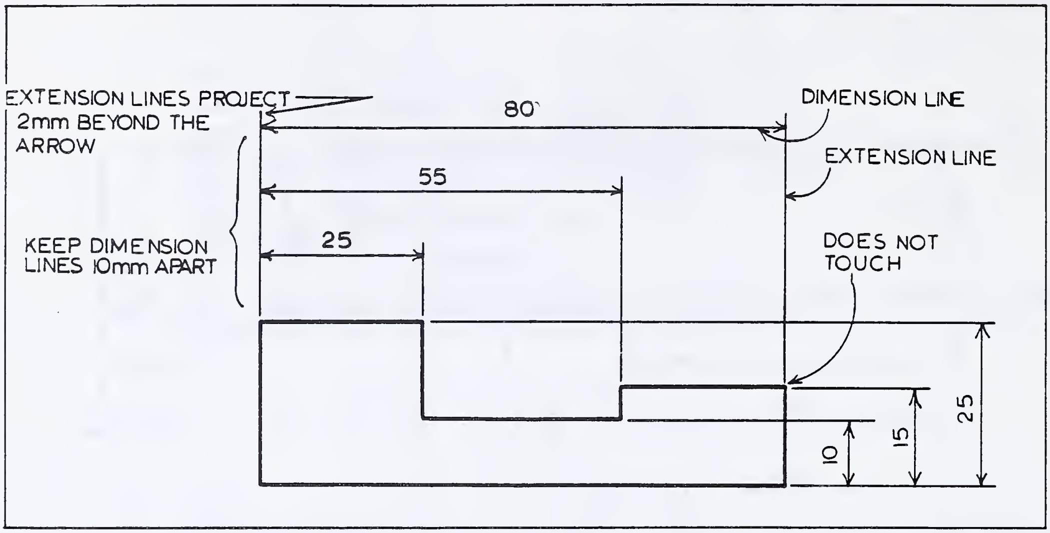


WINDOW STICK (Not to Scale)

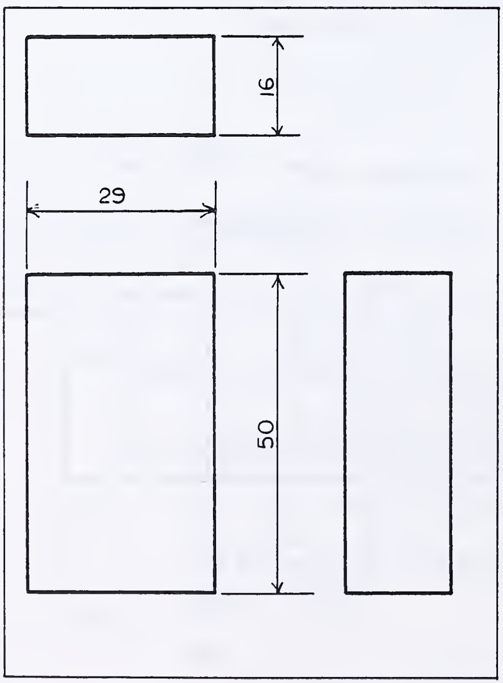


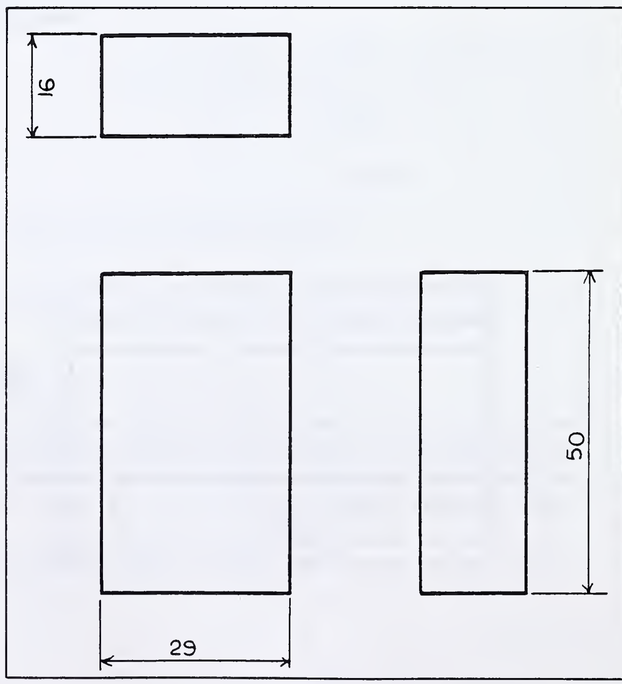
GROOVED BLOCK (Not to Scale)

More Examples of Correctly Dimensioned Drawings



Dimensions are placed between views whenever possible.





PREFERRED **NOT RECOMMENDED**

EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Fastening Paper on the Drawing Board

1. Why should you wipe the instruments each time you prepare to work?

____

____

2. Why must you carefully smooth the paper before fastening it with tape?

____

____

3. Why should you use masking tape in fastening drafting paper rather than cellophane tape?

____

____

EXERCISE 2: Drawing Horizontal and Vertical Lines

1. Why should you roll the pencil when drawing a straight line?

____

____

2. When drawing, is the head of the T square always held against one edge of the board, or may it be changed from side to side?

____

Answer TRUE or FALSE

3. In making a straight line, the straight edge should be brought up to the desired point and then the pencil placed against it. ____________

4. The pencil may be tracked back and forth when ruling lines. ____________

Fill in the blank with the most correct word.

5. Horizontal lines are drawn with the ________________ edge of the T square only.

Exercise 3: Locating Lines with a Pencil

Cross out the wrong word.

1. The pencil is pointed with a (chisel, conical) type of point.

Answer TRUE or FALSE

2. A large dot is the best way to mark the location of a line. ________________

Exercise 4: Dimensioning a Working Drawing

Fill in the blank.

1. In making dimension lines and extension lines, I would use a ______H pencil.
2. Whole numbers are ____________ mm high.

Underline the correct length.

3. Extension lines should continue beyond the arrowheads a length of
   (a) 12 mm.
   (b) 18 mm.
   (c) 9 mm.
   (d) 2 mm.

Underline the correct word.

4. Place dimensions (beside, under, between) views whenever possible.

Answer questions 5 and 6 either TRUE or FALSE.

5. Every working drawing must show all dimensions on all the views even though the edges are repeated. ________________
6. Extension lines should touch the corners of the object. ________________
7. Are numbers placed ABOVE or BELOW dimension lines?

   ____
8. How far, in mm, should a dimension line be placed from the object edge line?

   ____
9. If you had a choice in placing dimensions on the LEFT or the RIGHT side, which would be the preferred side?

   ____
10. Should numbers sit ON the dimension line, or be SLIGHTLY ABOVE the line?

    ____

EXERCISE 5: Drawing Arrowheads

Draw six 50 mm horizontal and six 50 mm vertical lines using a T square and triangle. Put an arrowhead on each end of every line. Make your arrowheads like those shown on page 6. Do not make the arrowheads too blunt.

EXERCISE 6: Practising Dimensioning

On pages 12 and 13 copy the WINDOW STICK and GROOVED BLOCK (as shown on page 7). Make your drawings actual size (that is, if a drawing has a dimension of 150 on it, then it should be drawn so it is actually 150 mm long). Do only one drawing per page. Do not just trace the drawing. It would also be a very good idea to review pages 5 and 6, **BEFORE** doing this last exercise.

NOTE: Because this exercise is **SO IMPORTANT**, it is essential that it be done **PERFECTLY**. Otherwise your teacher will return the exercise for you to do over again. **TAKE YOUR TIME** and do a good job **THE FIRST TIME AROUND**. It will pay off in your future lessons.

END OF LESSON 2

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

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Time Spent on Lesson

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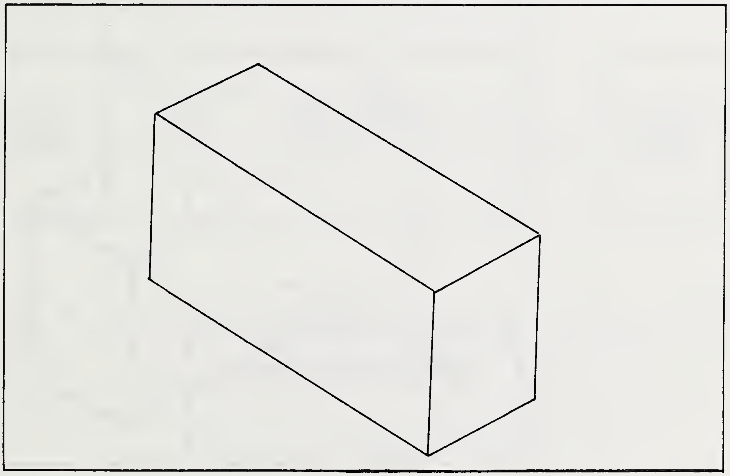
ORTHOGRAPHIC PROJECTION

This is one of the most important lessons in the entire course. The following lessons and most of the course use the methods and data presented in this lesson.

It is important that the student know this lesson 100%. **UNLESS YOU KNOW THIS LESSON PERFECTLY, YOU HAVE VERY LITTLE HOPE OF MAKING IT THROUGH THE REST OF THIS COURSE SATISFACTORILY.** Study this lesson very carefully, and if needed, study it twice.



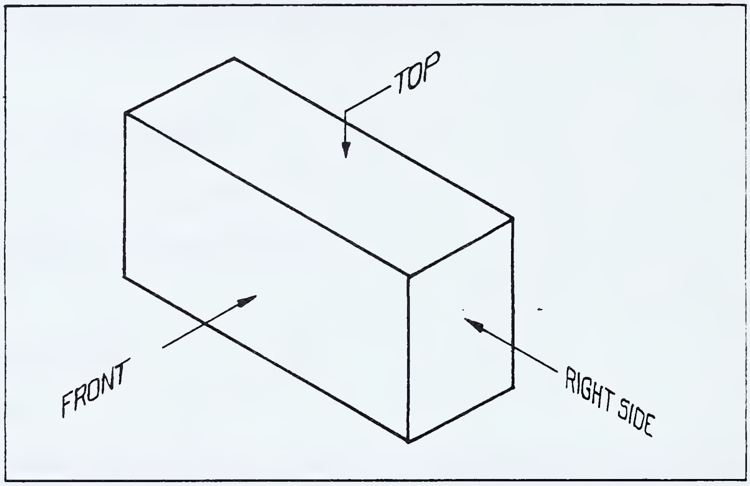
When we look at a solid object we cannot of course see all sides of it at once. Consider the simplest type of object, a rectangular block. If we turn the block slightly and place it below eye level, the most we shall be able to see is one end, one side, and the top. Furthermore, the angles and lengths will not appear in their true sizes.

A pictorial drawing is a drawing which shows an object as it looks to the eye. Such a drawing is not suitable for use in supplying the information required to make an object. It is the draftsman's job to create from the object or a pictorial drawing of the object, a set of working drawings which will provide all the information required to enable a workman to construct the object.

The working drawing separates the object into views. Each view is shown in its true shape and size. Also the views are shown on the drawing in their correct relationship to one another. The method used to achieve this is called **orthographic projection**. (Briefly have a look at the diagram on page 3.)

Using this method each view shows a face **as it appears from a point directly in front of it**. The front view is drawn as it appears when it is straight in front of the observer so that the line of sight between the surface observed and the eye is at right angles (perpendicular) to the surface. The top view is also drawn looking squarely at it from a point directly above. The side views likewise are drawn as if seen from points directly in front of the sides.

Consider a typical rectangular block as shown below. It has six sides or faces. To keep track of what we are talking about we shall give each face a name. The name we give to a particular face depends on the side of the block we choose as the base. To get the best picture we stand the block in such a way that one of the largest faces is facing us. The rectangular block shown below has one of its largest faces facing us.



The faces are named as shown in the above illustration.

The block has six faces but we can see only three of them. The faces which are hidden are:

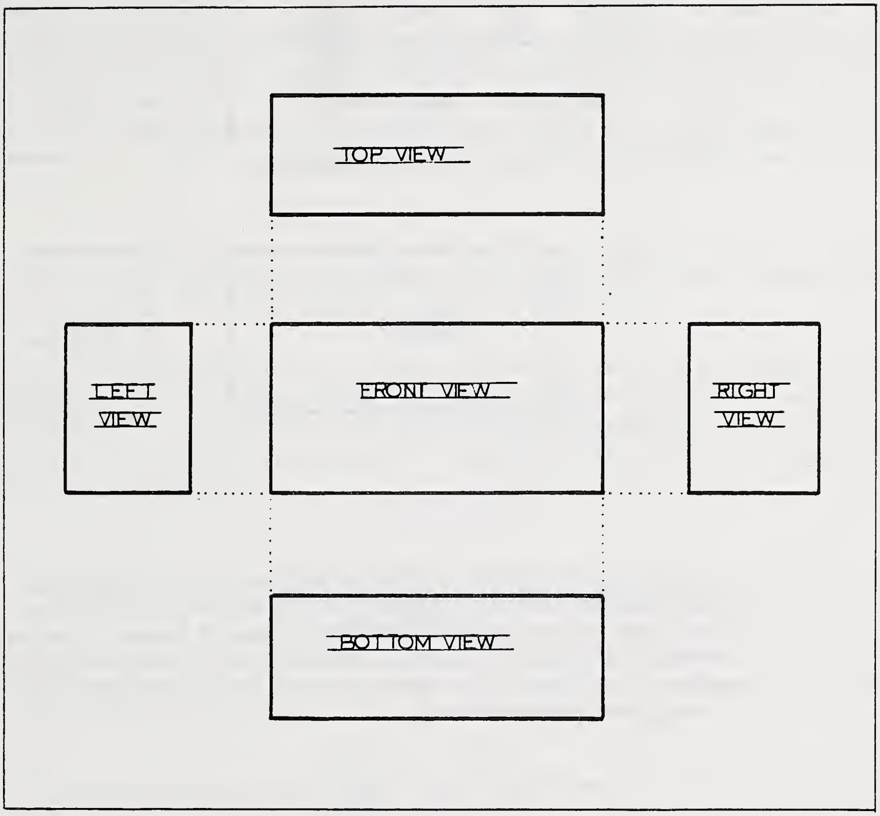
back;

bottom;

left side.

An orthographic drawing consists of a separate outline for each view. However, it is not necessary to draw all six views in order to portray all the details of the object. Usually three views are drawn, but sometimes two or even one view is sufficient. The separate outlines are arranged in a special way. Suppose we were to draw the top, front, bottom, and side views of the rectangular block. In the centre we put the front view. In line with this on the right side, we put the right side view. Also in line on the left side we put the left side view.

Still in line but vertically above the front view we put the top view. Likewise the bottom view is in line vertically below the front view. The diagram on the next page shows this in detail.

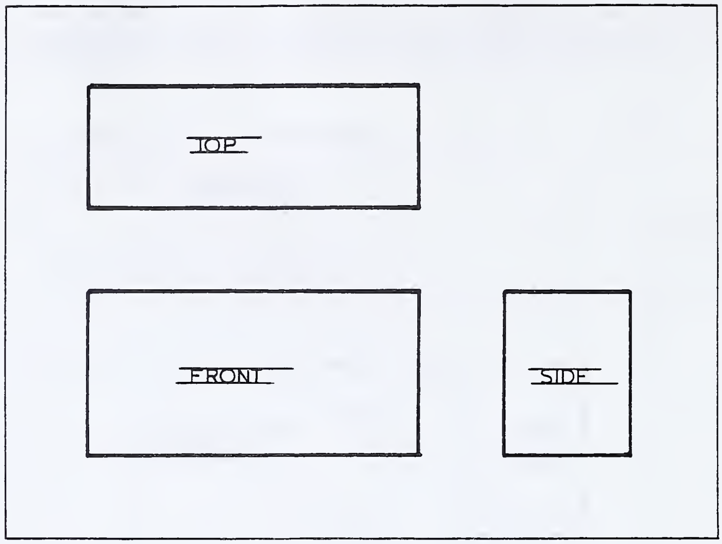


Notice how the views are placed perfectly **in line** with each other.

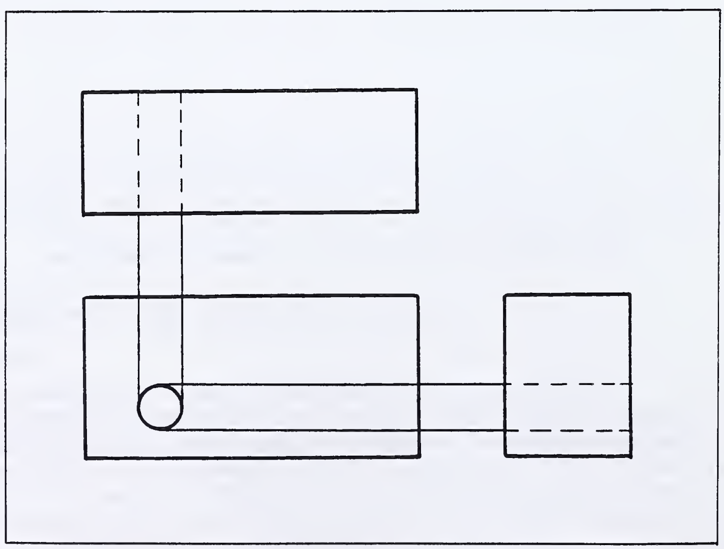
Note again how: the top view is **above** the **front** view.

the right view is to the **right** of the **front** view.

For most objects all six views are not needed since opposite faces are alike or nearly so. Usually, at most, three adjacent faces are sufficient. In this case the front, top, and right side views may be used, and they are placed on the drawing as shown on the next page.



Now suppose a fifteen millimetre hole was drilled through the front of the block. It would of course come out at the back. But it would not be possible to see the hole if the block were facing end on. Nor could you see the hole if looking at the top of the object. The draftsman must draw the views as if he had x-ray eyes and could see **ALL** edges below the surface of any face. These edges are drawn with hidden-edge lines and the orthographic drawing looks like the following.



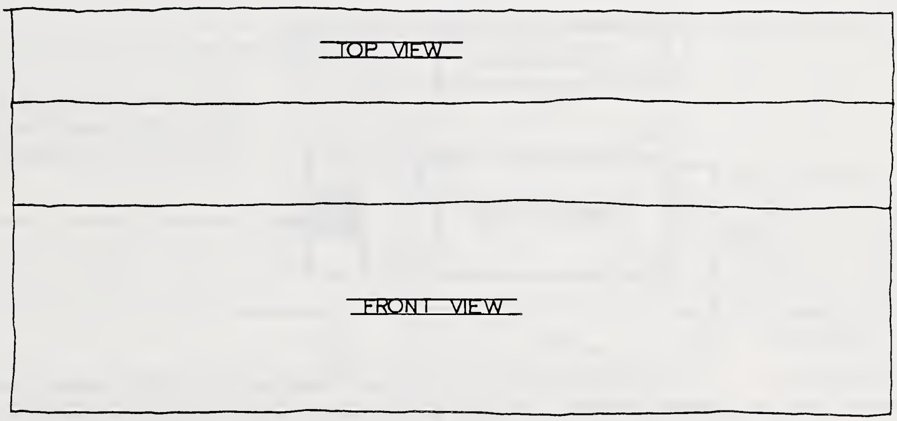
(Note how construction lines were used to assist in lining up the hidden-edge lines. When drawing board and instruments are used these might not be necessary.)

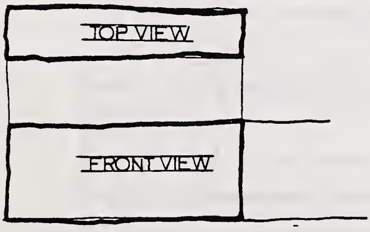
Sketching a Working Drawing (Orthographic Projection)

A free-hand sketch must first be made before any working drawing is made with instruments. The sketch must be complete. It must contain all the information which is required to be placed on the final drawing to enable workmen to construct the object. All the views which are required must be in the sketch and placed in correct relation to each other. Everything should be roughly in proportion or to scale. That is, if the length of a block is 100 mm and its width is 50 mm, the rectangle should appear to be twice as long as it is wide. However, do not make any measurements—estimate the lengths in proportion to each other by eye.

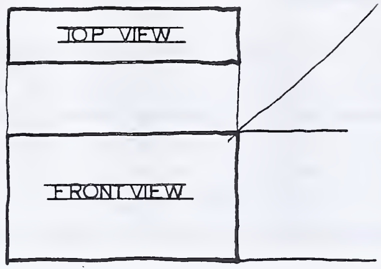
Working drawings are in orthographic projection. Projection is done by extending construction lines from one view to another. For example, let us consider a working drawing for a rectangular block which is 100 mm × 50 mm × 25 mm.

First we sketch the front view which will be the 100 mm × 50 mm surface. It will be a rectangle about twice as long as wide. The top view will show a 100 mm × 25 mm surface. To obtain the 100 mm length we simply extend the end lines upwards, then draw two more horizontal lines the right distance apart to represent 25 mm. Our drawing should look like this:

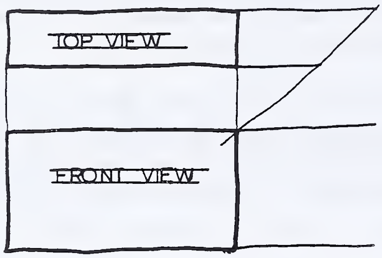




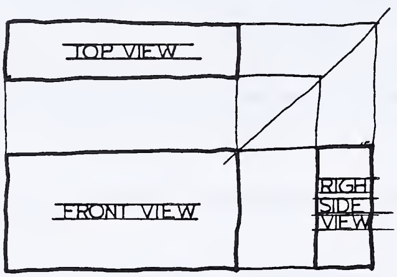
The right side view must now be added. The side of the block is a 50 × 50 mm rectangle. This rectangle is completed in the sketch simply by extending the lines we already have in the proper way. The 50 mm length is obtained by extending from the front view as shown.



Now we draw a line at 45° from the top right corner of the front view as shown.

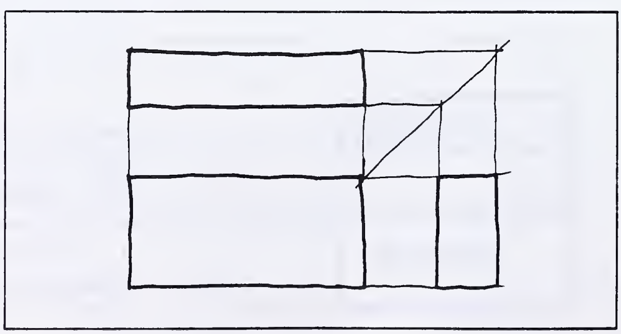


Then we just extend all the horizontal lines in the top view to meet this line.



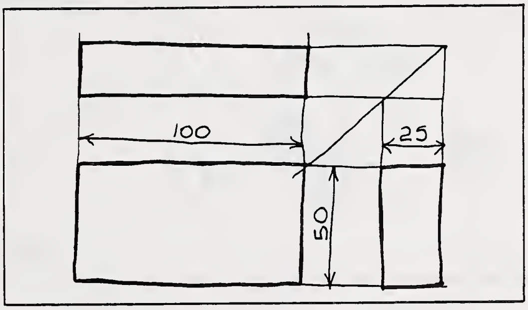
Finally we drop vertical lines down from each point where these lines meet the 45° line and our side view is complete.

If all the construction lines have been made very light we can now arrive at the sketch of the three views by heavying up the lines which actually show the three views of the block.

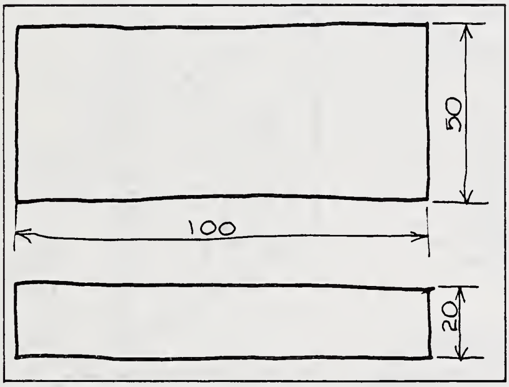


In problems as simple as this you will not need to use contruction lines at all, or you can make them exceedingly light. Unless your sketches are designed with these projection lines in mind you may make errors in projection from one view to another.

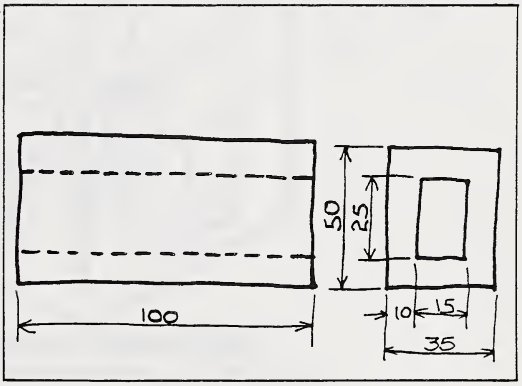
Before the sketch is finished, every dimension required by the workman must be placed. In the examples below note how enough space must be left between views to allow for the insertion of dimensions. Note also that the dimensions do **NOT** refer to the size of the **sketches** at all, but indicate the sizes of the **actual object**. What is required is to have the lengths in proportion. Use a 4H pencil for all preliminary sketching. Heavy up the object outlines (but not the dimension lines) with an H pencil. **Do not make any measurements when sketching.** Proportion the lengths by eye.



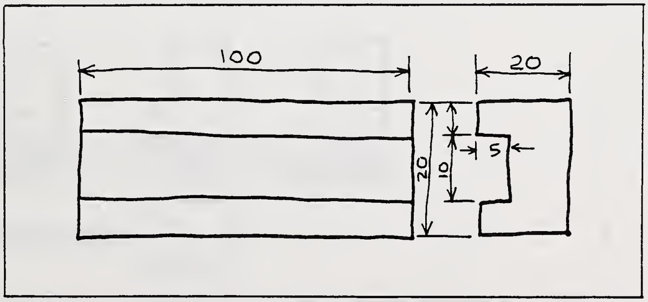
SOME EXAMPLES



RECTANGULAR BLOCK

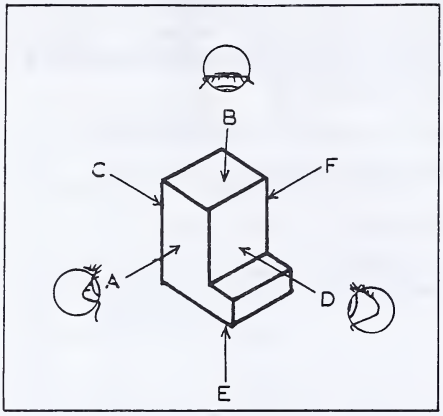


HOLLOW BLOCK



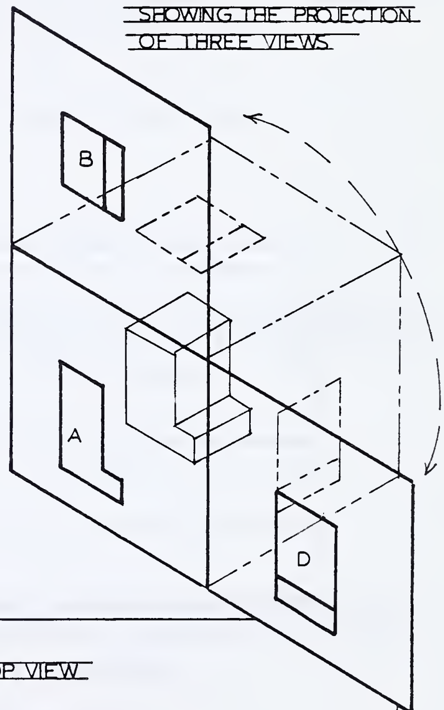
CHANNEL BLOCK

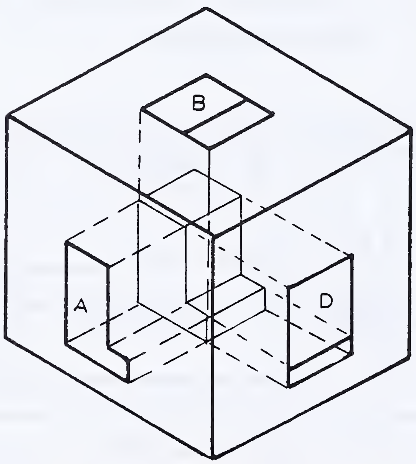
As an additional aid to understanding three views, you can think of the object as being enclosed in a glass box. The sides of the object are then projected onto the sides of the box. When the box is unfolded, the sides of the box show the views of the object.



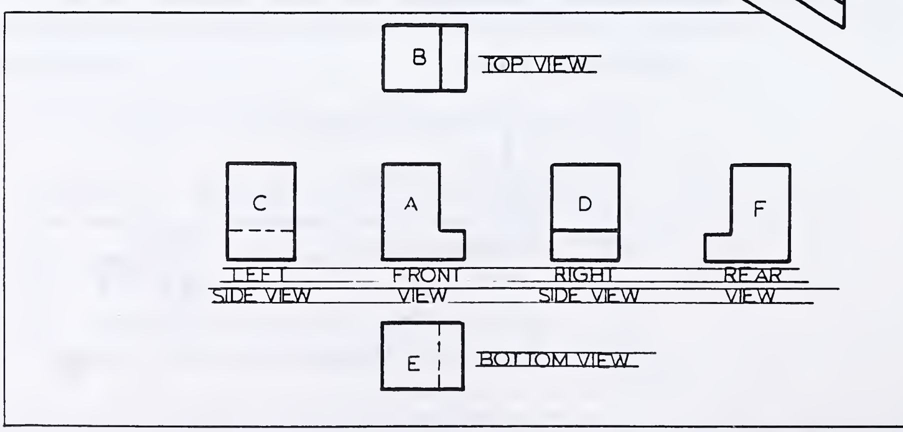
PICTORIAL VIEW OF OBJECT

GLASS BOX UNFOLDED SHOWING THE PROJECTION OF THREE VIEWS





OBJECT ENCLOSED IN GLASS BOX

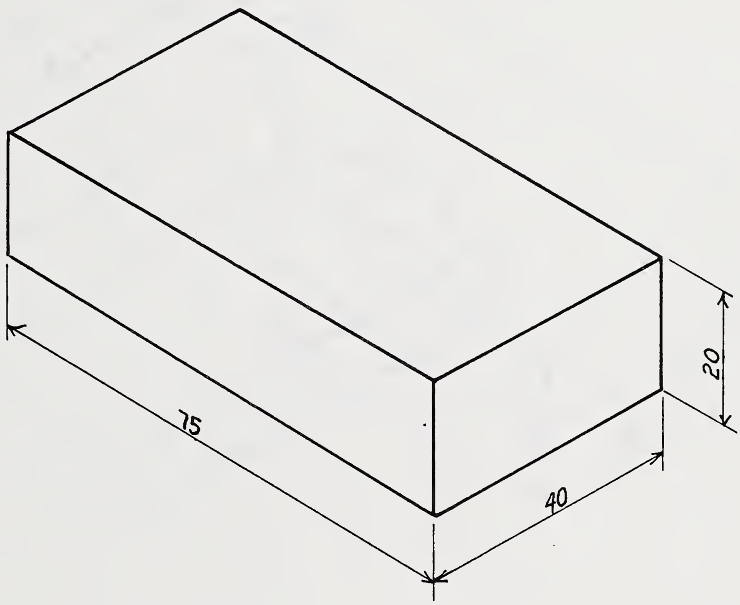


ORTHOGRAPHIC DRAWING SHOWING THE SIX PRINCIPAL VIEWS

EXERCISES TO BE SENT IN FOR CORRECTION

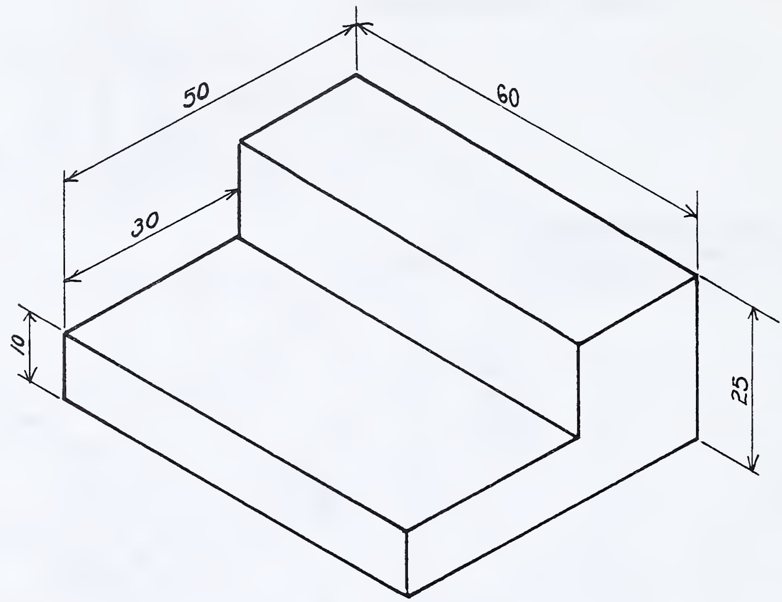
Exercise 1: Sketching a 3-View Orthographic Drawing

In the space below the pictorial drawing, make a 3-view orthographic sketch of the object, showing front view, top view, and right side view. Show all construction lines and necessary dimensions.

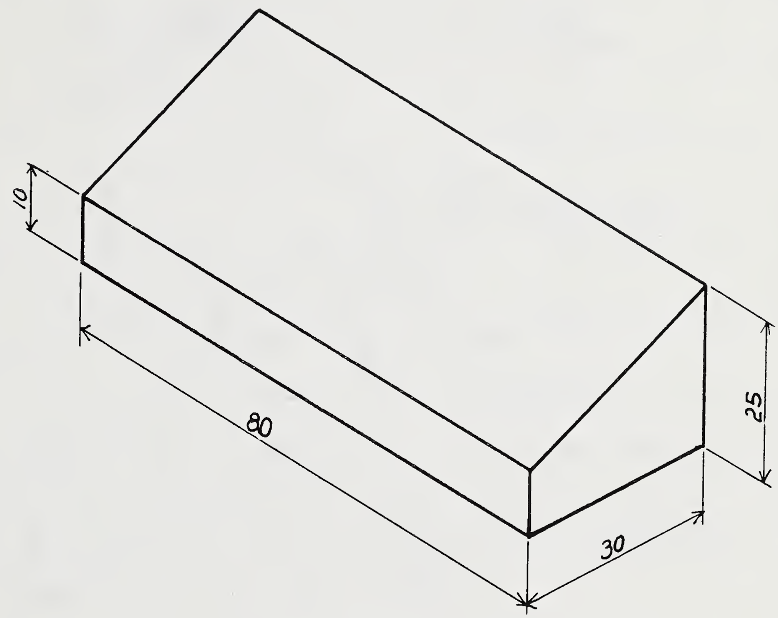


Exercise 2: Sketching 3-View Orthographic Drawings

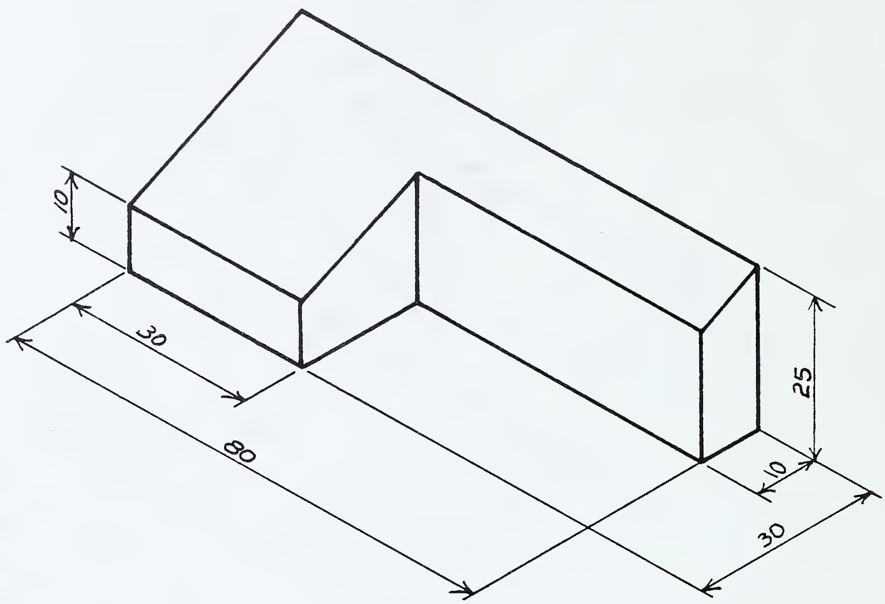
1. Make a 3-view orthographic sketch of this object. Show the front, top, and right side views. All construction lines and necessary dimensions should be shown.



2. Make a 3-view orthographic sketch showing the front, top, and right side views of the object depicted below.



3. Make a 3-view orthographic sketch, showing the front, top, and right side views of the object depicted below.



END OF LESSON 3

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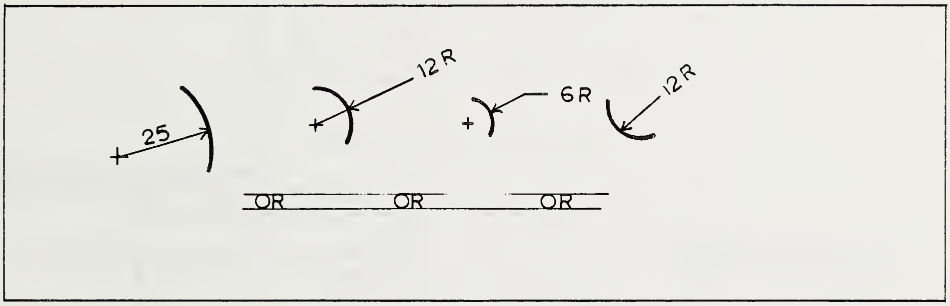
BLUEPRINT READING AND SKETCHES IN ORTHOGRAPHIC DRAWING

Dimensioning Circles and Arcs

A circle is dimensioned by giving its **DIAMETER**.

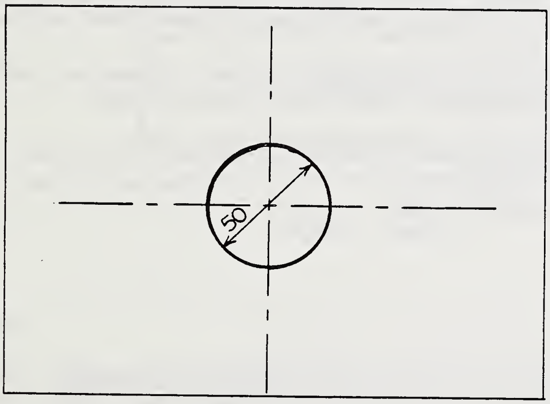
An arc is dimensioned by giving its **RADIUS**.

The dimension line for an arc may extend from the centre of curvature in any of these ways:

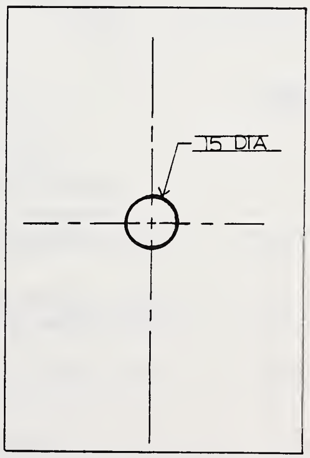


The letter **R** serves to remind the workman that it is the radius of arc that is being stated. Similarly, **DIA** may be added to the dimension of a circle but it is not essential.

Whenever a circle is drawn, centre lines are shown to help the workman locate the position of the circle. Then the dimension line is inserted, usually in this manner:



If the circle is too small to put the dimension within it, then use a leader line like this:

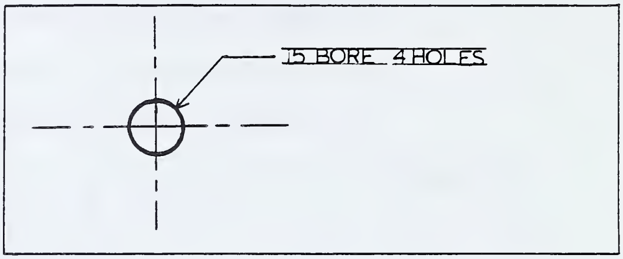


MAKE SURE THAT THE ARROW POINTS EXACTLY TO THE CENTRE OF THE CIRCLE

See that the dimension stated is the **diameter**, not the radius.

Sometimes directions must be stated in words in order to indicate all the detailed information required on the drawing. A light, unbroken line with an arrowhead is drawn at an angle from the part in question and the desired information is lettered at the end of it. This line is called a leader.

EXAMPLE:



Some lines are marked like this:

Here's why.

Some of the working drawings are of wooden objects and some are of metal objects. Some metal objects are made by casting. This means that molten metal is poured into a mold where it hardens into a solid object. When the object is removed from the mold its surface will be rough. Smoothing the rough surfaces is known as "**finishing**." Whenever two surfaces of a machine slide on each other or must fit together closely, these surfaces must be finished.

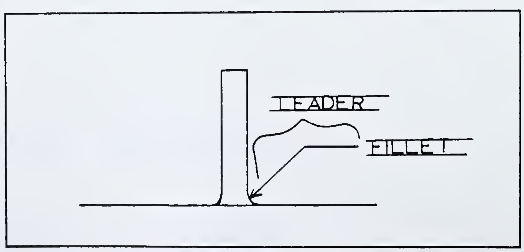
This finishing may be done on a grinder, a planer, a shaper, or a milling machine. These are all machines which could be found in a typical machine shop.

Whichever machine is used, the surfaces which are to be finished must be indicated on the drawing. This is done by using the letter "*f*" along all the lines which represent the edge of the surfaces to be finished.

Fillets

When two surfaces meet in a casting they do not come together sharply at right angles. Instead, a small inside curve is formed between them. This is called a **fillet**. The fillets add strength to the casting so that it will not crack. The radius of the fillet may be indicated on the drawing.

Note that there are fillets between the centre support and the bracket sides, and between the sides of the bracket, as shown below.



EXERCISES TO BE SENT IN FOR CORRECTION

In Lesson 3 we discussed how to make an orthographic working drawing of an object. In this exercise we are going to look at some working drawings which are already made and learn to read correctly the information which is on them. Begin by reading Lesson 3 again. As you do so, look at Figures 1 through 5 of this lesson and see how what we discussed in Lesson 3 is applied to each of these figures. The first four figures show three views: front, top, and a right side. Notice in particular how the visible edge lines line up in the three views.

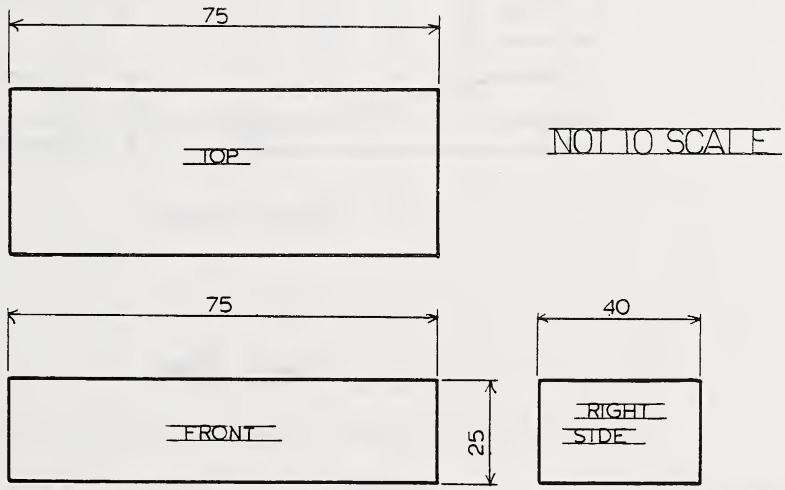


Figure 1: BLOCK

EXERCISE 1: Block

1. The length of the block is ______________________.

2. In which views did the length appear? Top, Front, Side (circle)

3. In which views did the width appear? Top, Front, Side (circle)

4. In which views did the thickness appear? Top, Front, Side (circle)

5. Does the same size have to be given twice on the same drawing? ______________

6. One size is given twice. Which should be erased? ______________________

   Why? ____

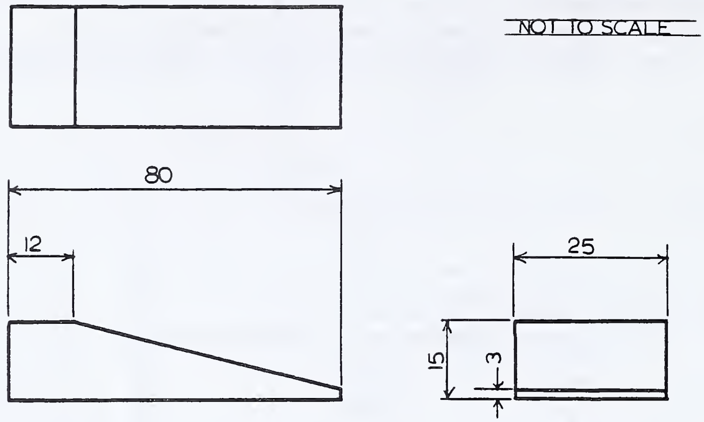


Figure 2: WEDGE

EXERCISE 2: WEDGE

1. In Figure 2, the slanted top of the wedge results in a visible edge line 3 mm from the bottom in the right side view. If the left side view had been drawn, would this line be drawn as a visible edge or as a hidden edge?

   ____

2. The length of the wedge is ______________________.

3. The width of the wedge is ______________________.

4. The thickness of the wedge at the smaller end is ______________________.

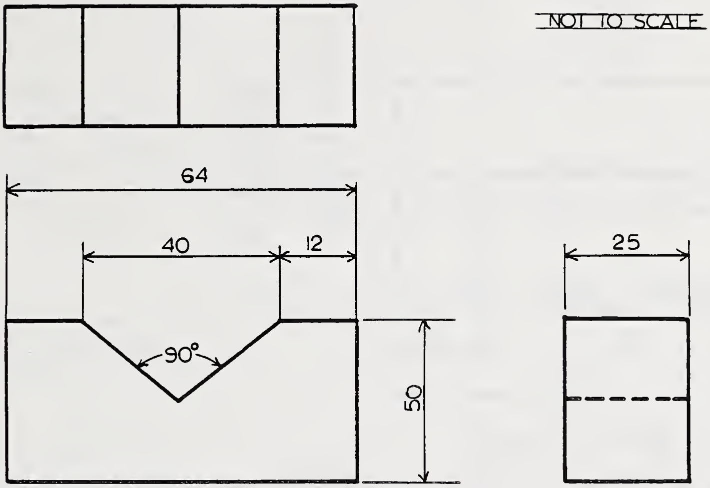


Figure 3: V-BLOCK

EXERCISE 3: V-BLOCK

1. In Figure 3, why is there a vertical line in the centre of the top view?

   ____

2. Why is there a hidden edge line in the right side view?

   ____

   ____

3. The length of the block is ______________, while the height is ______________.

4. The thickness of the block is ______________.

5. The top view and the ______________ view show the thickness or width.

6. The front view and the ______________ view show the height.

7. The front view and the ______________ view show the length.

8. The width of the "V" at the top is ______________.

9. The distance from the edge of the "V" to the end of the block is ______________.

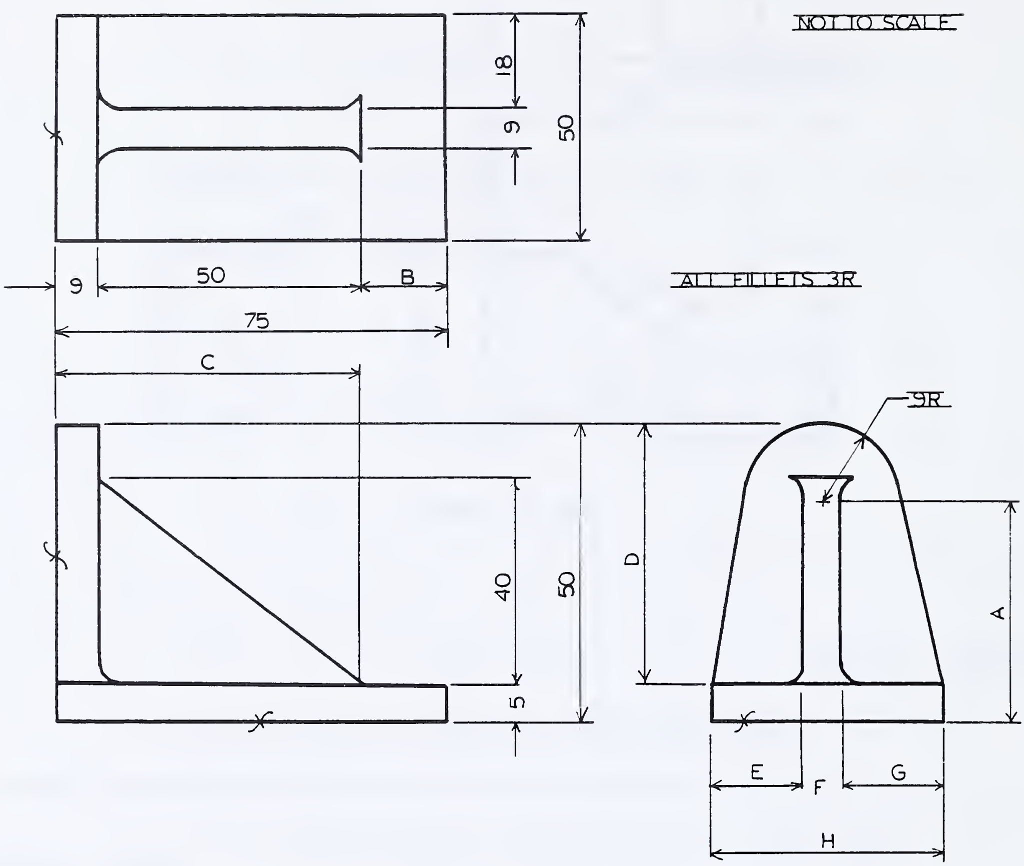


Figure 4: BRACKET

EXERCISE 4: BRACKET

1. What does "$\not{f}$" mean? ____________________

2. In Figure 4, what size of dimensions do the following letters represent?

A =	C =	E =	G =
B =	D =	F =	H =

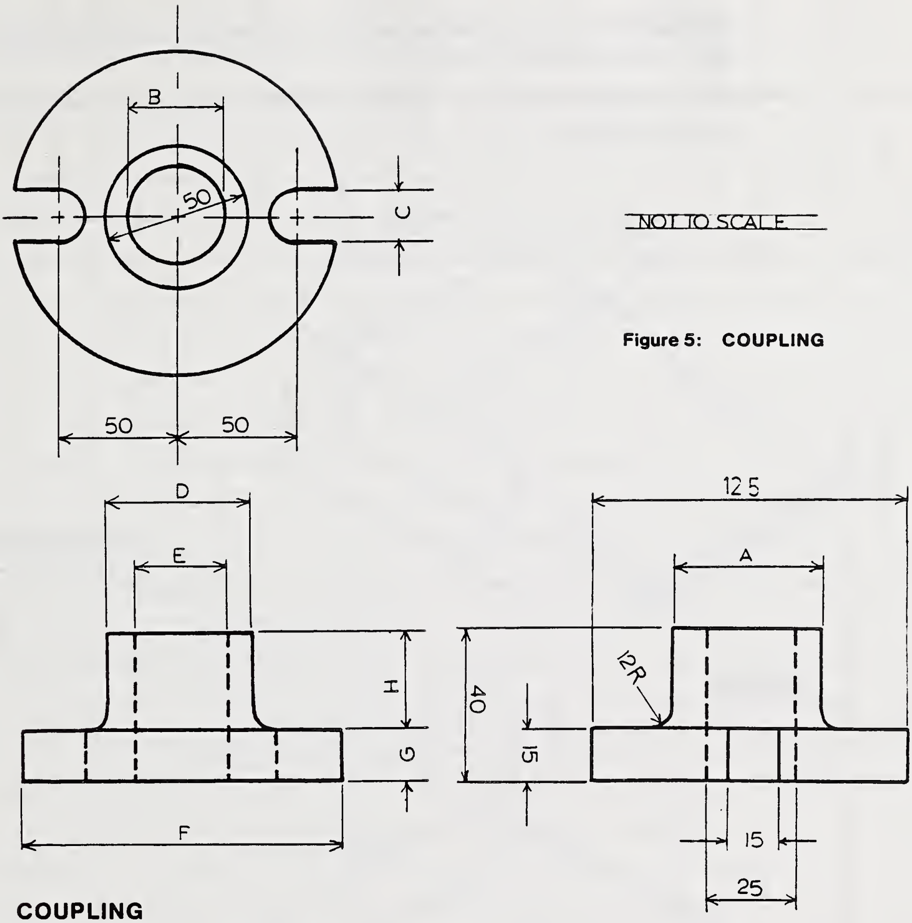


Figure 5: COUPLING

EXERCISE 5: COUPLING

In Figure 5, what size of dimensions do the following letters represent? (Due to the way the views are positioned, you have a bottom view shown instead of a top view.)

A =	C =	E =	G =
B =	D =	F =	H =

EXERCISE 6: Practising Orthographic Drawing

Make a 3-view orthographic drawing showing the **FRONT, TOP,** and **RIGHT SIDE VIEW** of each of the objects shown on page 8.

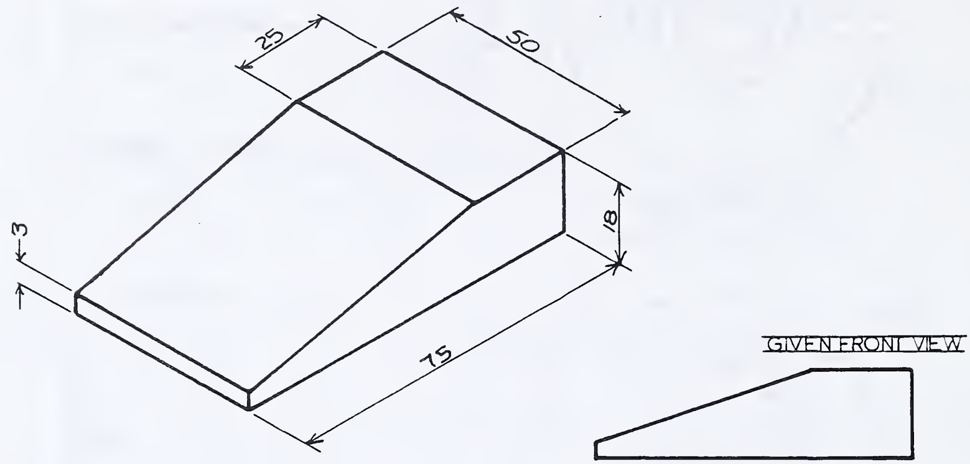
1. Sketch the views on scrap paper first. Leave enough room between the views to insert dimensions. Use an H pencil for sketching. Remember that each drawing requires three views properly lined up. Recopy the front view you are given, and draw in the other two views. It is not necessary for you to send in the scrap paper drawings.

2. Using the squared paper provided, pick an appropriate scale to fit two objects on one page. Let 1 square equal 10 mm for example. Note that the dimensions shown are those of the object, not of your drawing.

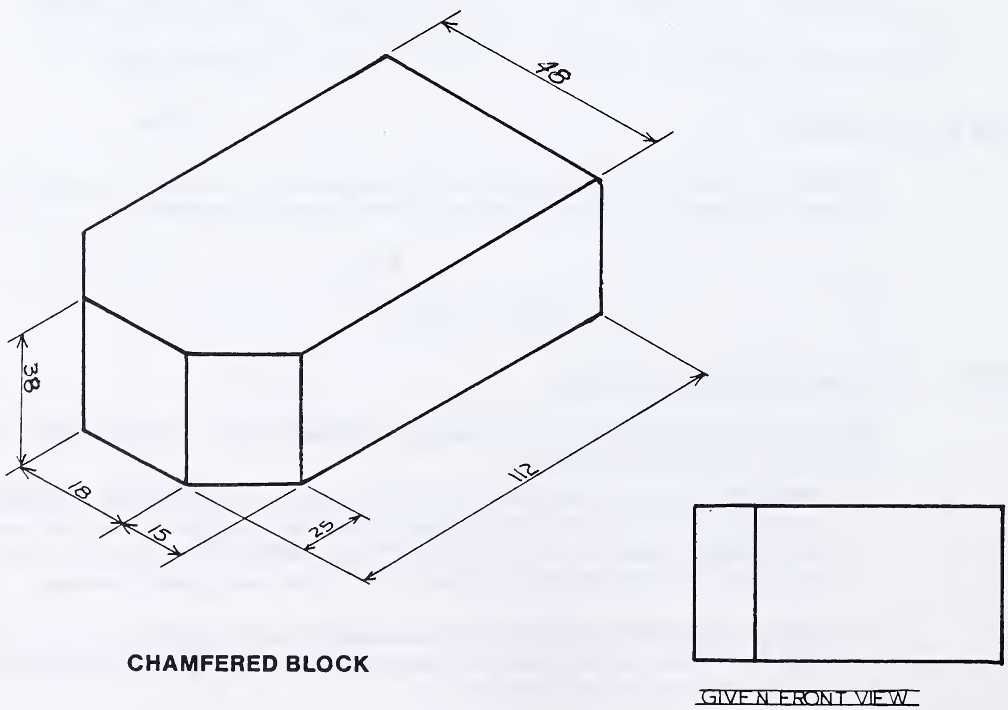
3. Copy the views you have sketched onto the squared paper provided, using the squares to get the lengths in proportion. Everything is done freehand and no instruments are to be used.

4. Insert all the necessary dimensions using extension lines, dimension lines, and numerals. Show each dimension only once.
5. Below each drawing, indicate the title, using the correct style of drafting lettering.

E.g.: BLOCK



WEDGE



CHAMFERED BLOCK

END OF LESSON 4

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

FOR STUDENT USE ONLY	
Date Lesson Submitted ______________	(If label is missing or incorrect)
	File Number ______________
Time Spent on Lesson ______________	Lesson Number ______________

FOR SCHOOL USE ONLY

Assigned Teacher: ______________

Lesson Grading: ______________

Additional Grading E/R/P Code: ______________

Mark: ______________

Graded by: ______________

Assignment Code: ______________

Date Lesson Received: ______________

Lesson Recorded ______________

Student's Questions and Comments

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Name

Address

Postal Code

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

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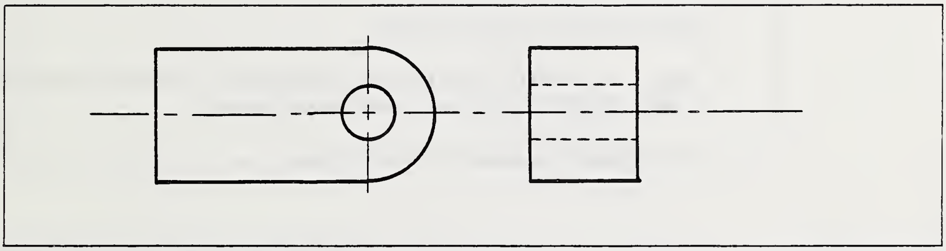
MAKING AND CHECKING A COMPLETE WORKING DRAWING

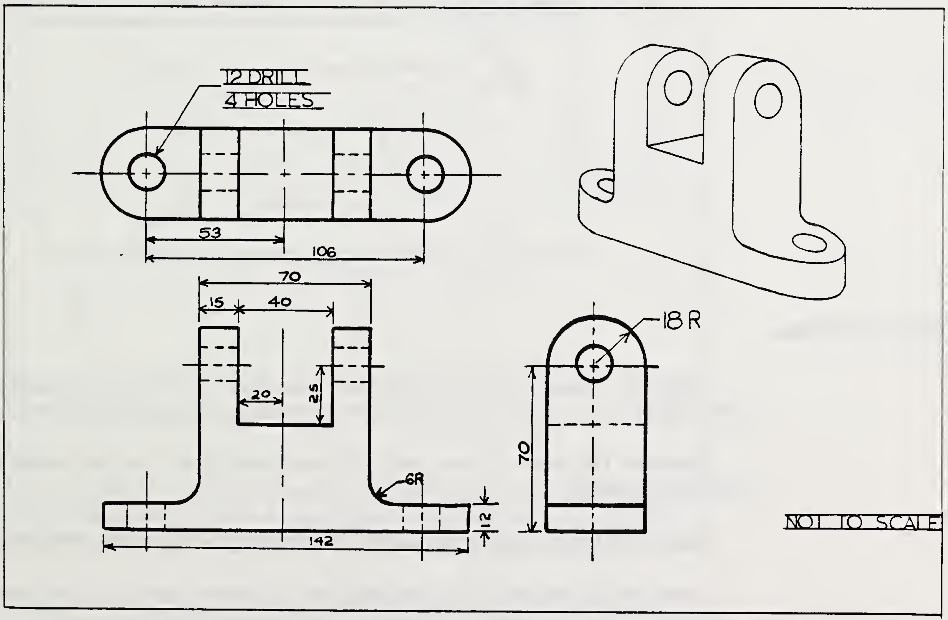
Number of Views

Whatever object a draftsman is required to draw, he must decide what views are necessary in order to show clearly the exact construction of the object. A flat, wafer-like object like a gasket, would require only one view. We have seen that a uniform rectangular block can be completely represented by two views.

When holes are bored in a surface, they will show as circles in the view facing the hole. In the view at right angles they will appear as hidden edges. See the drawing below. (Note the centre lines.)



If the object has holes at right angles to each other, it is advisable to draw three views so that all holes will be represented both as cirlces and as hidden edges. Centre lines are drawn at right angles for each hole so that the location of the hole centres can be indicated by dimension lines. (Holes are located by their centres, not by their edges.) Study the following example.



The working drawing above required three views to show all necessary details.

Laying Out a Drawing Sheet

The drawing sheets used in this course are located after Lesson 16. Enough sheets are supplied to enable you to complete this course. The sheets measure 216 × 280 mm. Make your drawings within a 204 × 254 mm border. Please make the borders you require for this lesson. Starting with the next lesson, you may use the plates with the borders already drawn on them.

To prepare a sheet ready for setting a drawing on, you are required to do the following steps.

1. Fasten the paper on the drawing board as described in Lesson 2. Keep it toward the upper left of the board well away from the ledge at the bottom of the board.

2. Find the centre of the sheet.

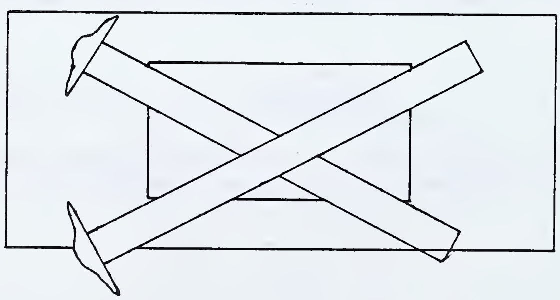
3. Rule the 204 × 254 mm border.

4. Rule a record strip at the bottom of the sheet 11 mm wide above the border. (The sheet is to be placed lengthwise on the drawing board.)

Do all ruling very lightly with a 4H pencil.

Finding the Centre

Place the blade of your T square across the sheet with the upper edge from the top left corner of the paper to the bottom right corner. Rule a line near the middle of this distance. Then move the blade and place it from the bottom left to the top right corner of the paper. Rule a short line which crosses the first line. Where the lines cross is the centre of your drawing paper.



Ruling the Border

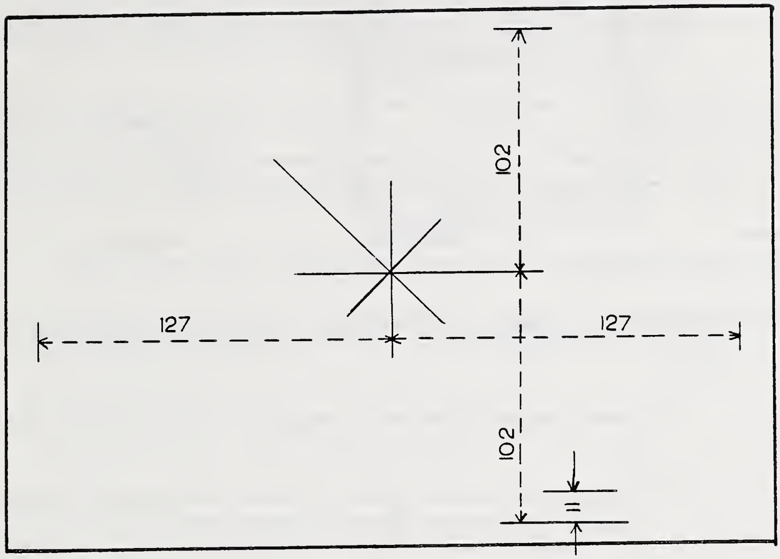
With the T square draw a horizontal line about 30 mm long through the centre. Place a triangle on the T square and draw a short vertical line through the centre.

Measure 102 mm up from, and 102 mm down from the horizontal line to locate your horizontal borders.

Measure 11 mm up from the bottom border to give you the top line of the record strip.

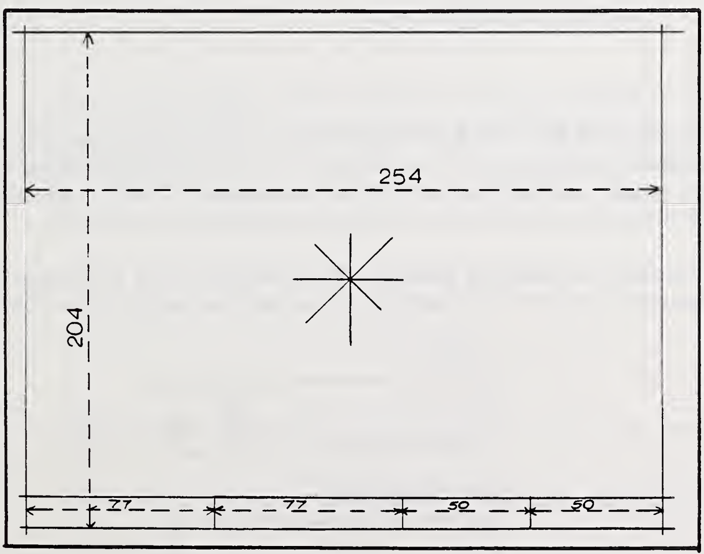
Measure 127 mm to the left and right of the vertical line to locate your vertical borders.

Your sheet will now show the construction lines and measurement strokes illustrated on the next page. Of course the dimensions on our illustration will not appear on your sheet.



Partitioning the Record Strip and Ruling the Borders

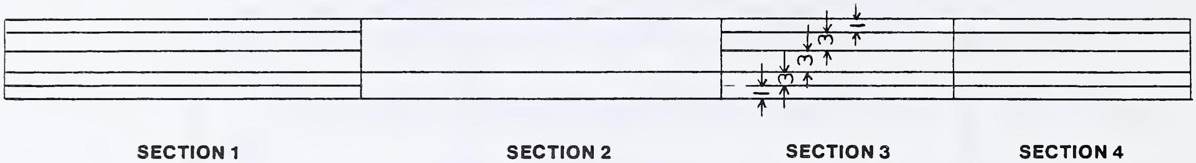
Measure distances 77 mm, 77 mm, 50 mm apart starting from the left border, within your record strip. Now use the T square to draw all the horizontal lines required and use T square and triangle to draw all the vertical lines required. You should end up with the lines lightly drawn in this way:



The light lines should overlap slightly at the corners. Leave things that way until the drawing is entirely completed. Then the required border lines will be heavied up. The heavy lines must **MEET EXACTLY** at the corners. No overlaps or gaps are then acceptable.

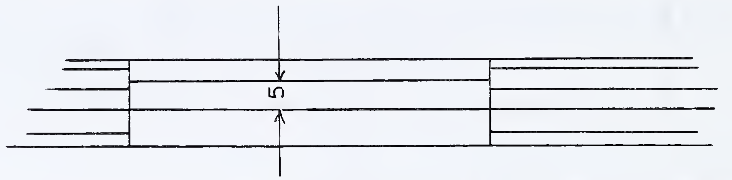
Ruling the Record Strip

Now rule the guide lines for lettering the record strip as shown below.



Rule the horizontal guide lines in section 1, and in sections 3 and 4 with a single setting of the T square.

Also draw a second guide line in section 2, 5 mm above the first.



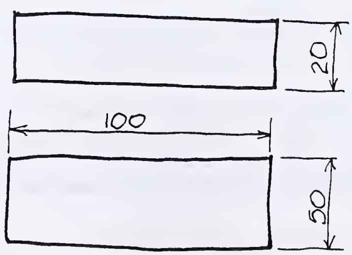
Now, as a final step **erase the centre marks** in the centre of the page.

The drawing sheet has now been provided with the light outlines of a 204 × 254 mm border with an 11 mm record strip at the bottom divided into 77, 77, 50, 50 mm sections ruled with guide lines for lettering. Such a sheet is called a plate.

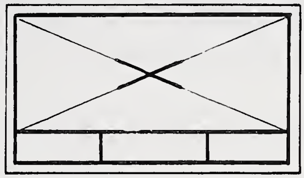
Blocking In

Nothing can be done on the drawing board until a sketch has first been made freehand on a separate piece of paper. This will show you all the items which must appear on the drawing in their proper relative positions. With this information you will be able to see where the centre of the drawing is, and then lay out your measurements accordingly.

Consider the following example. The drawing is for a rectangular block so two views are adequate to show it. It is decided to draw the front and top views. Our sketch is like this:

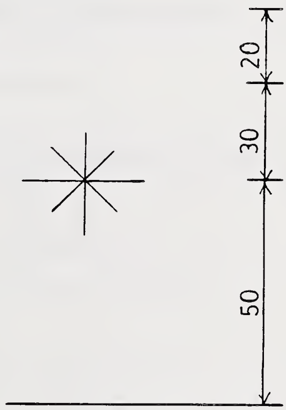


We will leave 30 cm between views for dimensioning and so the overal height of the drawing is 100 mm. The dimensions on the right project about 10 mm so the overall length is 110 mm.

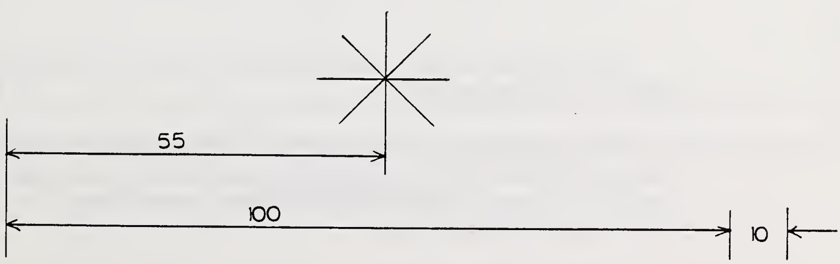


At this point make a **new** centre mark within the **inside border** of the plate.

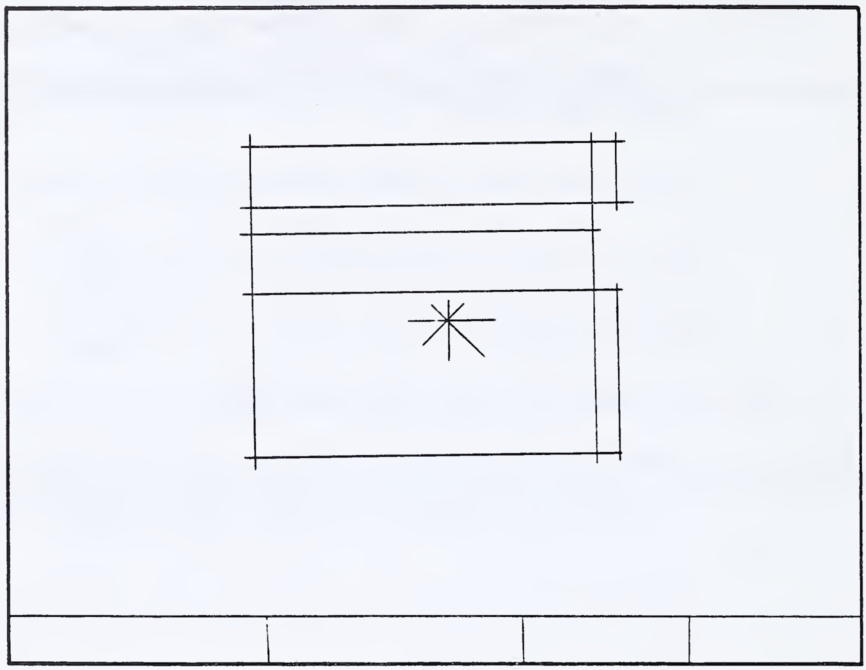
Since our drawing is to be 100 mm high, measure down half this distance from the new centre, namely 50 mm.



The overall length of the drawing is 110 mm (allowing 10 mm for dimensioning). Therefore, the left edge of the drawing will be 55 mm from the centre. Mark the line locations as follows:



You now have the positions of your 5 horizontal lines and 3 vertical lines marked. With a T square rule all the horizontal lines from the top one down. Place a triangle on the T square and draw all the vertical lines, in order, starting at the left side. When the blocking in has been done you will have these lines, as shown below, all very lightly drawn with your 4H pencil.



Your drawing has now been blocked in so that it is centred on the plate and fills the space available adequately.

The extensions lines, dimension lines, and arrowheads can now be outlined on top of these guide lines. When the dimension numerals have been inserted, the object edge lines, borders, and record strip partitions heavied up with H pencil, and the record strip lettered, the drawing will be complete.

It is not necessary to draw continous lines when blocking in. You can see from your sketch where gaps should occur and you can make the extension lines the correct length to begin with, instead of drawing them on top of a continuous line. The important thing is to line up all segments which are in line and draw them with a single setting of the T square or triangle.

1. Front and Side Views:

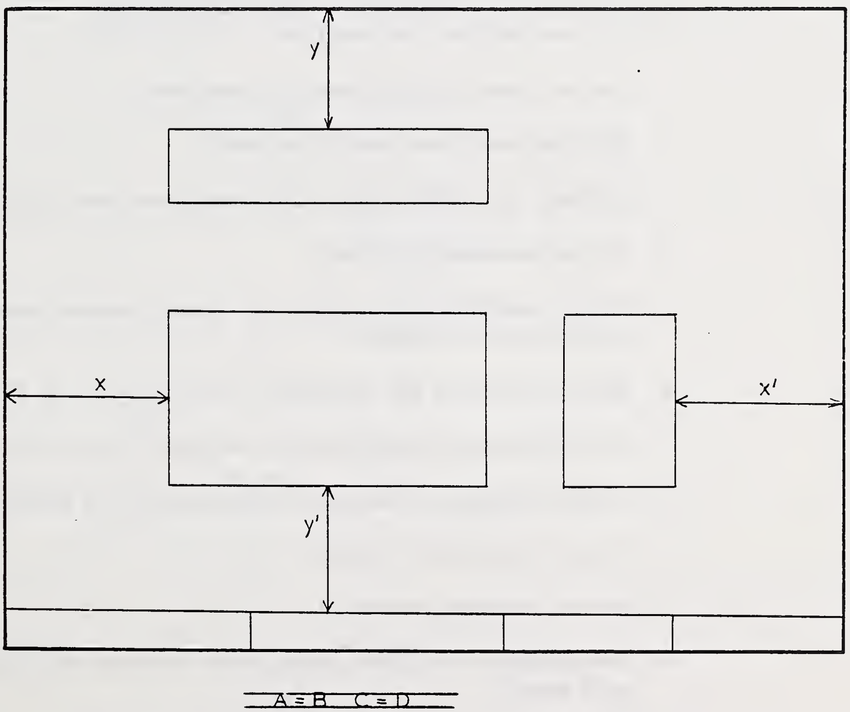
If your drawing consists of front and side views, add together all the lengths you will require including enough space for dimensions, as determinined from your sketch, divide by two, and then measure off this distance to the left of your centre line, to find the left end of the drawing.

Similarly, find the total height you will require and measure down half of this distance from the centre.

2. Three Views:

The same system is used for a 3-view drawing. The left end of the front view will be as far from the left border asthe right end of the right-side view (**including dimension lines**) is from the right border.

Similarly for the top and bottom of a drawing follow the illustration as shown below.



Note that if the drawing (including dimension lines) is properly centred:

x will be equal to x^{I}
and y will be equal to y^{I}.

Record Strip

The record strip is to be lettered as follows.

CORRESPONDENCE	SANDBLOCK	DR.BY	DATE
SCHOOL		CH. AP.	SCALE : 1:1

After **DR. BY** (drawn by), sign your name. After **CH.** (checked) write your initials after you have checked to see that all details of your drawing are correct. **AP.** stands for "approved." If your drawing is found to be correct your correspondence instructor may initial it.

Refer to the check list below whenever you make a drawing.

Check List for Drawings

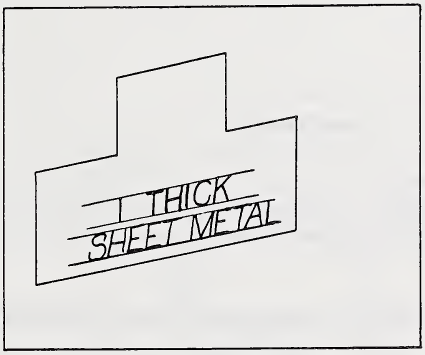
1. Is the drawing centred on the plate?
2. Is it neat and free from smudges?
3. Are the views in proper relation to each other?
4. Have the views been correctly projected?
5. Are there centre lines for all circles and symmetrical objects?
6. Are all dimensions provided?
7. Are the dimensions found easily with related dimension together so the workman will not have to hunt for them?
8. Have you repeated any dimensions? If so, erase the one which is more remote.
9. Do all dimension figures and notes read from the lower right corners of the drawing?
10. Is your lettering style the correct standard set out in Lesson 2?
11. Are all words spelled correctly?
12. Are all arrowheads drawn in?
13. Are all object lines, hidden edges, border lines and record partitions heavied up with an H pencil?
14. Do all lines meet exactly at corners when heavied up?
15. Have all erasing particles been brushed off?

EXERCISES TO BE SENT IN FOR CORRECTION

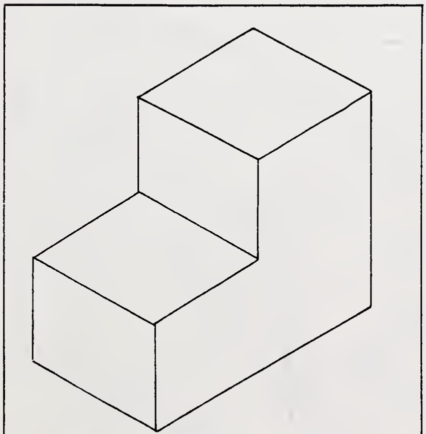
EXERCISE 1: Number of Views

Decide how many views would be needed to show each of the following objects on a working drawing. Then sketch the views properly lined up in relation to each other. Do not draw more views than would be necessary. Position the objects to show edges as visible rather than hidden, but show all hidden edges where necessary. Neglect dimensions. Draw your sketches with a hard pencil in the space below.

1. The object shown is a template. It is used for reproducing multiple outlines of its shape by tracing around the edges. The edges of the template are all at right angles though the pictorial view does not show them that way. Sketch the working drawing with all angles true size.

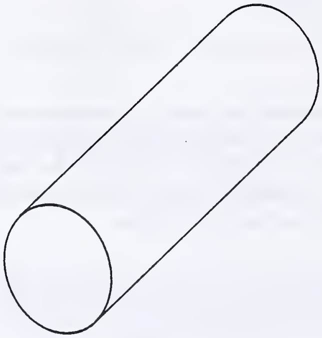


2.



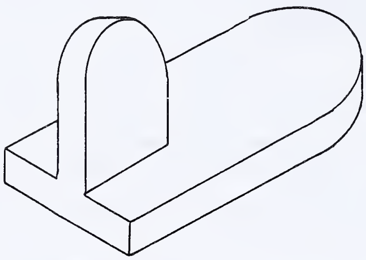
Seat

3.



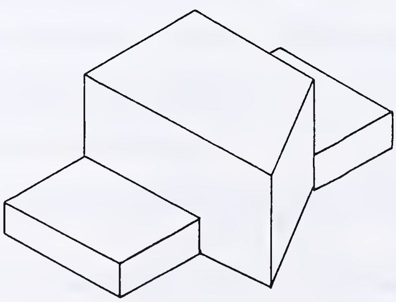
Rod

4.



Widget

5.



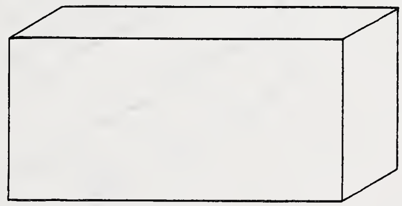
Gizmo

EXERCISE 2: Preparing Plates

Prepare 3 plates as shown on pages 2, 3 and 4. We shall use each of them to make a finished drawing.

EXERCISE 3: Centering a Drawing

Problem: Draw a 2-view (front and top) working drawing of the Sand Block; dimensions 20 × 50 × 100 mm, on one of the plates you have prepared.



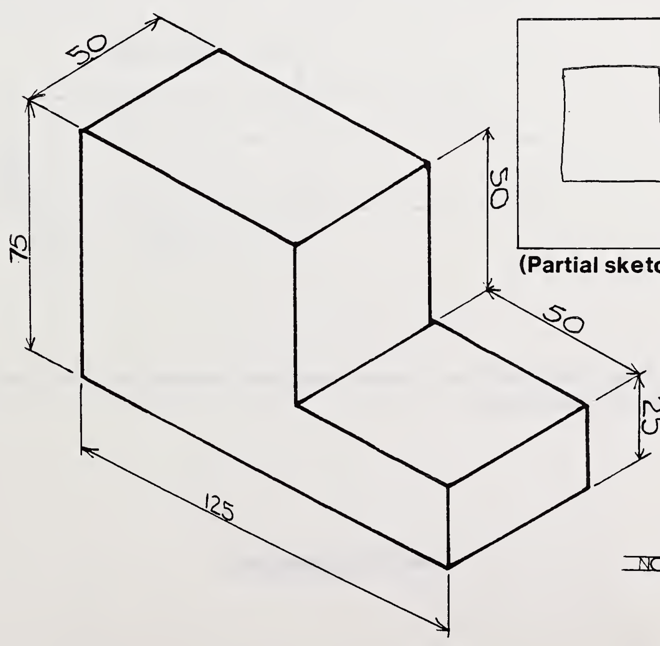
Sand Block

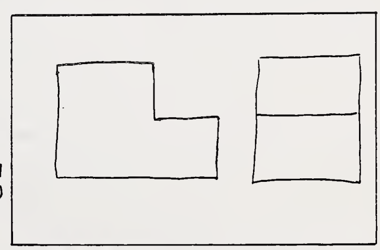
Centre and block in your drawing as instructed. See that all object edge lines, borders, and record strip partitions are heavied up with an H pencil and all dimensions are properly shown, with extension and dimensions lines and arrowheads. Letter the record strip.

EXERCISE 4: More Working Drawings in Orthographic Projection

1. First sketch a 2-view working drawing of the Seat on a separate piece of paper, then lay out the views on your second prepared plate and make a finished working drawing complete with dimensions and the correct weights of lines properly centred. Letter the record strip. Attach the sketch to the finished plate.

NOTE: Sketches may be done on looseleaf or other paper, and they do not have to be full size.

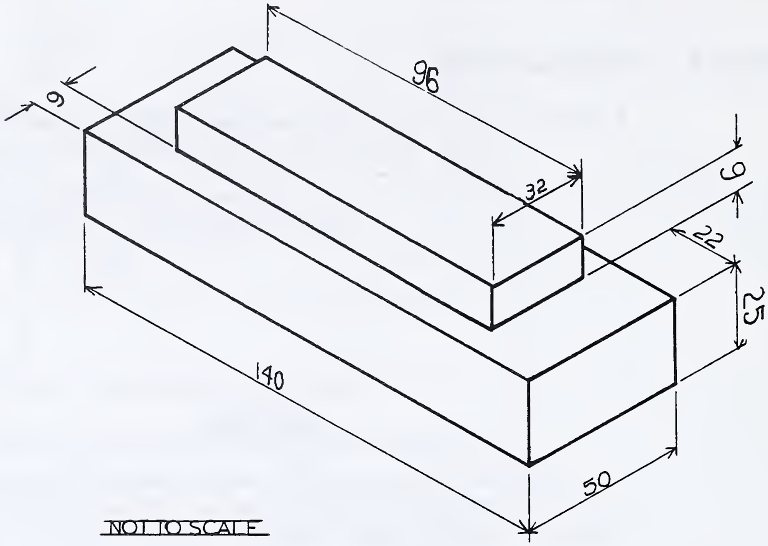




(Partial sketch. Add dimensions.)

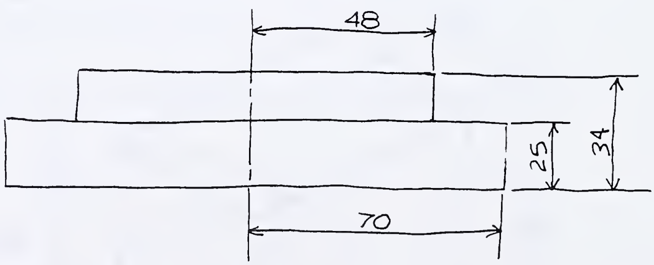
NOT TO SCALE

2. Sketch front, top and right side views of the Weight. Then make a complete working drawing on your third prepared plate. (Attach your sketch to your prepared plate.)



Weight

When an object is symmetrical dimensioning is simplified if you dimension from a centre line.



Before sending in your lesson check each drawing with the check list we have provided on page 8 of this lesson.

END OF LESSON 5

LESSON RECORD FORM

1715 DRAFTING 10

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Date Lesson Submitted

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File Number

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Lesson Number ____________

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Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ______

Date Lesson Received:

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HIDDEN EDGE LINES, OBLIQUE LINES, PARALLEL

Lines Used in Drafting

In Lesson 1 we described in detail the types of lines and what they are used for. You have drawn object lines, border lines, dimension and extension lines, and guide lines with your instruments, and you may have used hidden edge lines in your sketches.

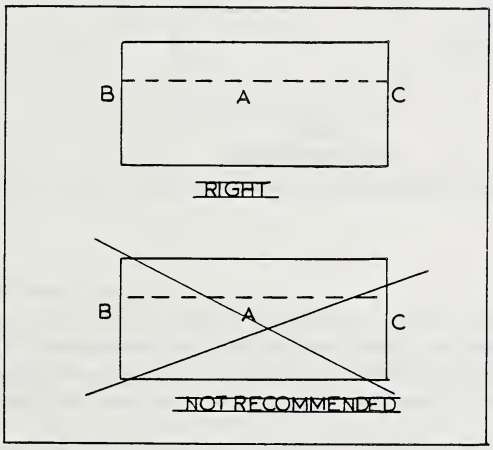
Hidden Edge Lines

There are two problems which arise when using these lines on drawings.

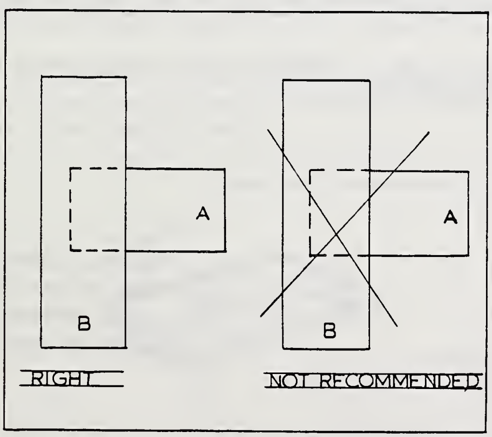
1. What do we do when hidden edges and visible edges meet?

2. What do we do when hidden edges meet each other?

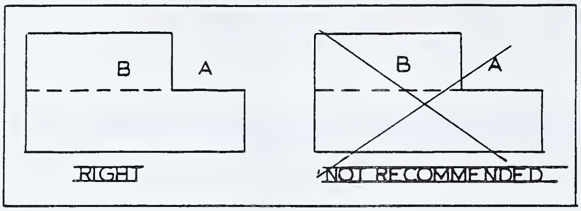
We can best answer these questions by illustrating the situations with drawings.



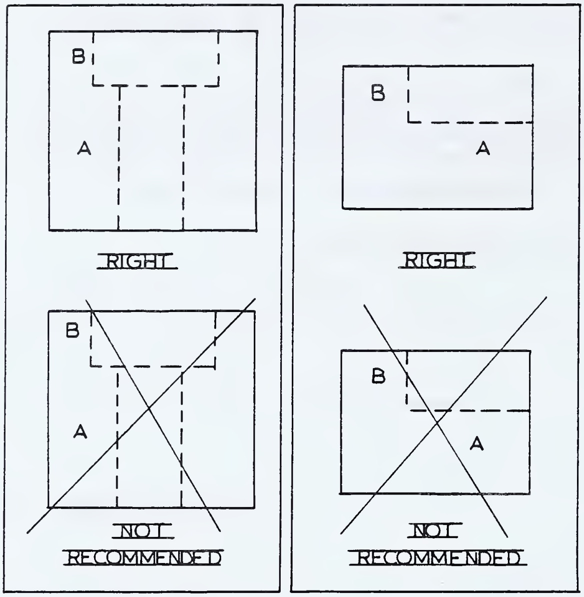
Hidden edge A meets surfaces B and C. Note that the dashes **MEET** the visible edge lines.



Peg A fits into socket B. The hidden edge lines are a continuation of peg A. Where A becomes invisible, a **SPACE** is left.



Visible edge A does not extend beyond the vertical edge. A **SPACE** is left between A and B.



Hidden edges A and B meet. The dashes must also meet.

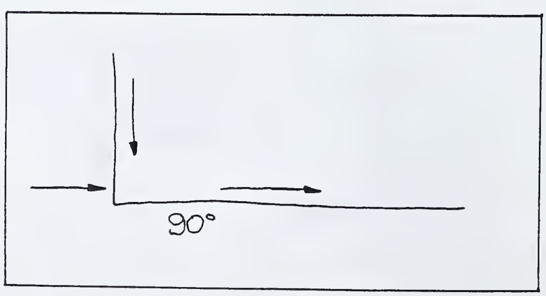
Oblique or Inclined Lines

An oblique or inclined line is one which is neither horizontal nor vertical. Such a line lies at an angle with the horizontal. Your triangles and T square enable you to draw lines at angles of 30°, 45°, 60°, or 90° with the horizontal. When drawing lines at these angles always place one edge of the triangle along the blade of the T square, not along a previously drawn horizontal line alone.

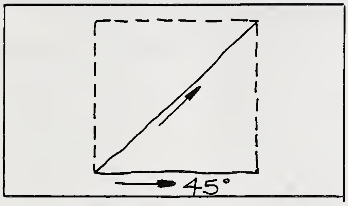
The triangles can also be used to draw angles of 15° and 75°, as we shall see.

When sketching, do not use the triangles to draw oblique lines. You should be able to sketch the lines by judging the angles by eye.

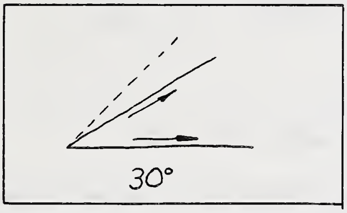
Sketching Angles



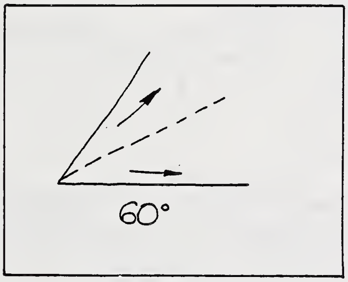
An angle of 90° with the horizontal is easy to sketch. Just draw a down stroke followed by a stroke to one side or the other.



Draw a 45° angle by mentally considering a square. The diagonal makes a 45° angle with either side.



To draw a 30° angle estimate $\frac{2}{3}$ of a 45° angle.



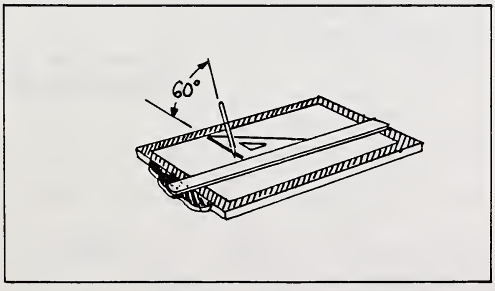
If you practice 30° angles, you can make a 60° angle by estimating double the size of the 30° angle.

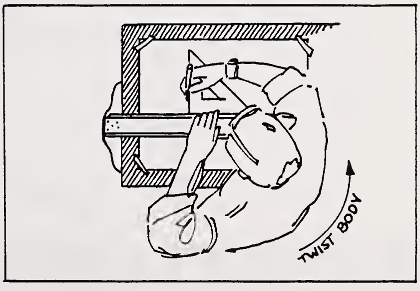
Note directions of the pencil strokes, shown by the arrows in each drawing.

Drawing Oblique or Inclined Lines

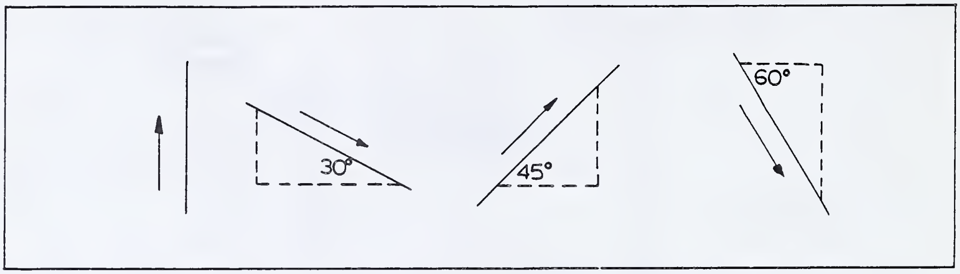
When you are drawing horizontal lines, you draw them from left to right, provided you are right-handed. (If you are left-handed, then all lines should probably be drawn in the reverse direction, from right to left.) It seems the natural thing to do, to draw from left to right. There is a reason why this seems so natural. As you place the pencil point against the T square blade, your hand and your pencil slope naturally toward the right. (Your pencil makes an angle of about 60° with the paper, in the vertical plane.) Thus, as you move, so you **PULL** your hand and pencil along the blade. You pull the pencil; you **DO NOT** push it.

We want to draw all inclined lines so that the pencil will be pulled, not pushed, along the edge of the triangle. Therefore, we draw vertical lines **UPWARD** with the wrist curved as shown in the illustration below.



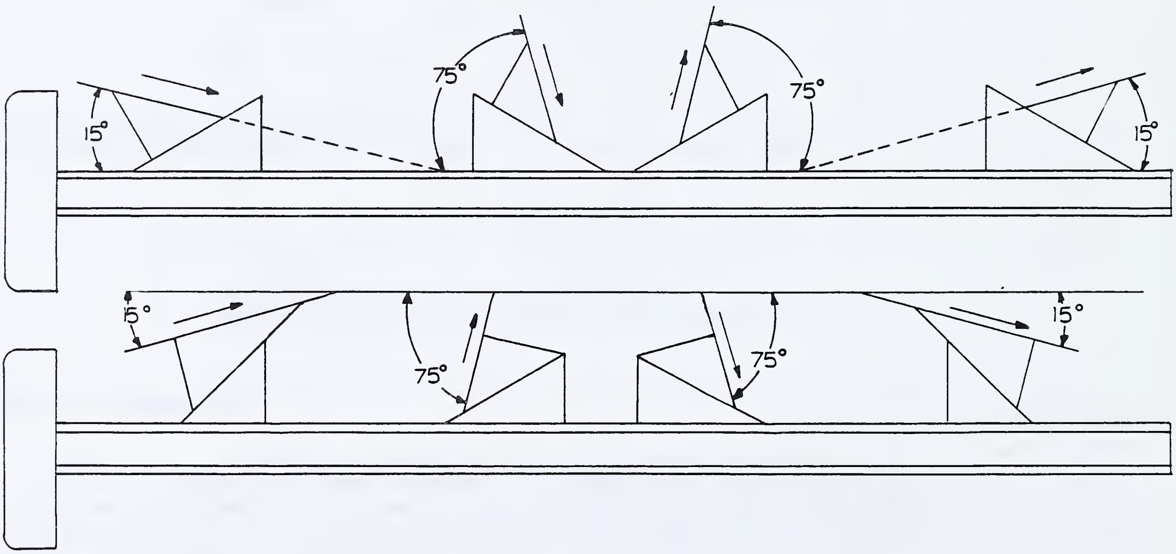


Since we want to pull the pencil not push it, we draw inclined lines starting at the left and finishing at the right end of the line, as shown below.



Using Two Triangles to Draw Angles of 15° and 75°

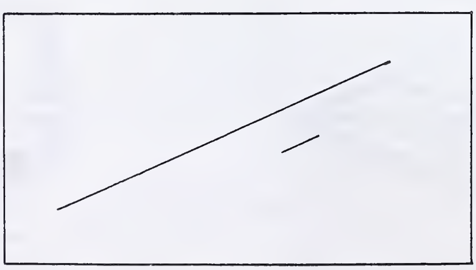
Place the triangles' longest sides together, as shown in the drawing below, to get angles of 15° or 75° with the horizontal or vertical.



Parallel Lines

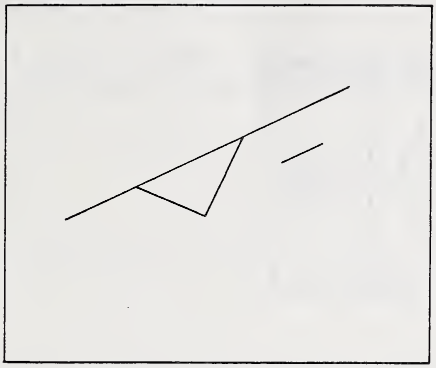
Use the following steps to draw any number of lines parallel to a given inclined line.

1. Suppose the given line is slanted like this.

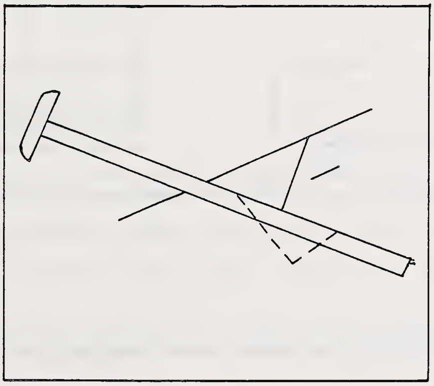


We want to draw a parallel line through this point.

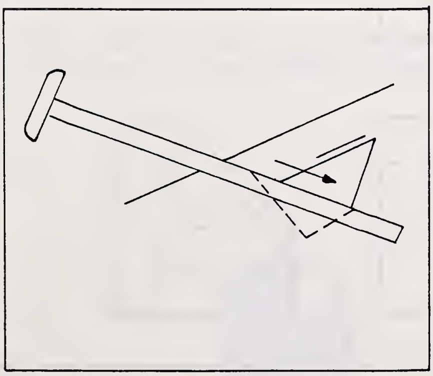
2. Set the long edge of either triangle along the line.



3. Set **EITHER** the T square blade or the long edge of the other triangle along one of the other edges of the first triangle.

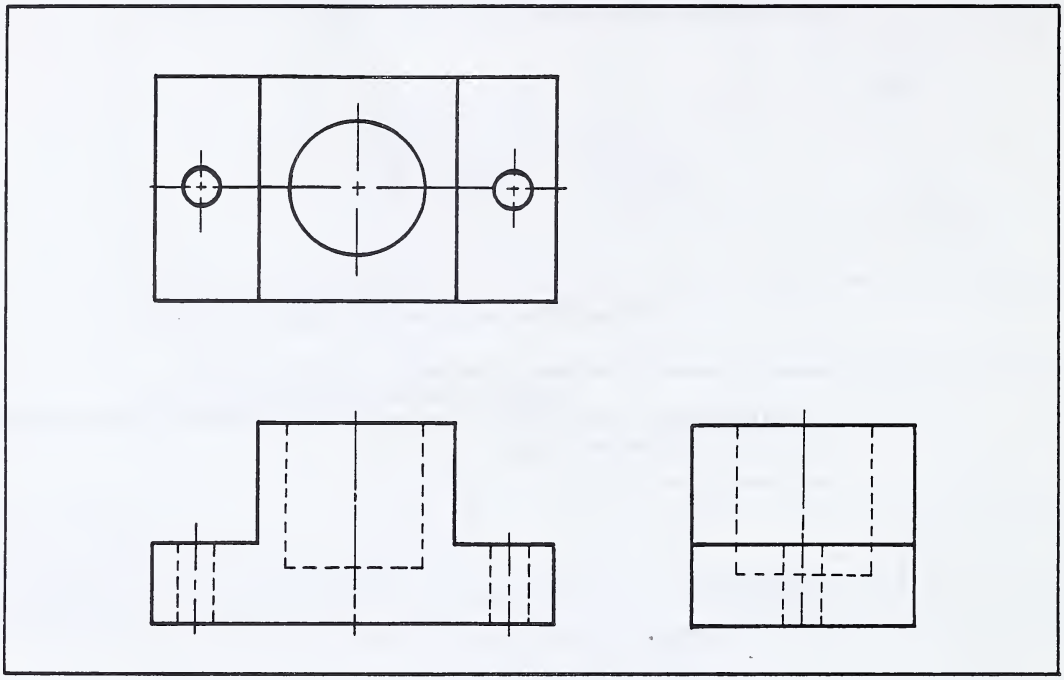


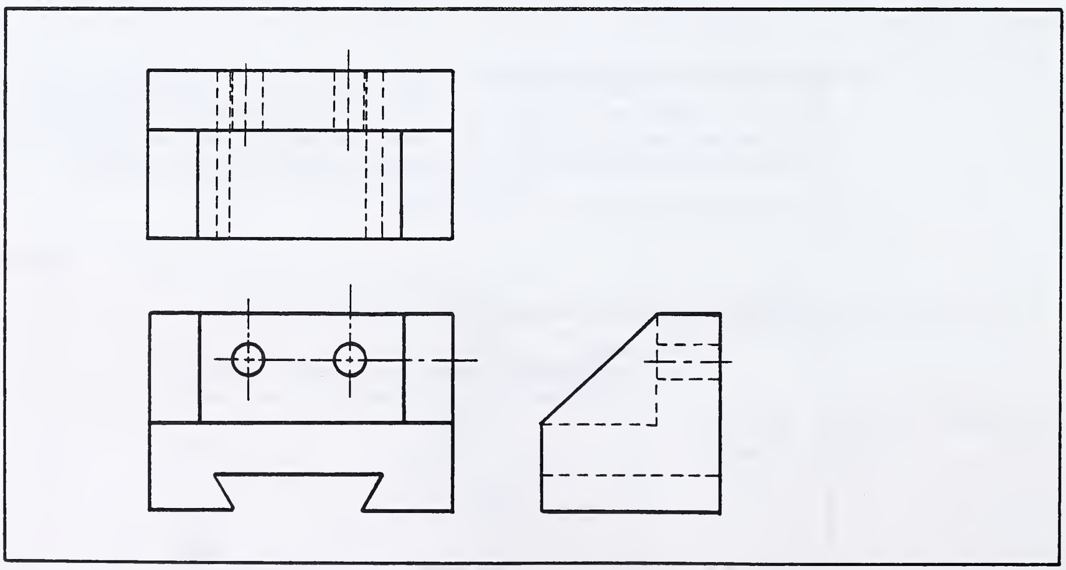
4. Slide the first triangle along the T square to where the desired parallel line is to go. Place your pencil point on the mark and secure this triangle's edge against it. Then draw the line along the triangle edge. It will be parallel to the original line. Make sure your T square or second triangle remains firmly in place during the sliding.



NOTE: Any number of parallel lines can be drawn by sliding the first triangle along to different positions, always keeping the T square or second triangle securely fixed in position.

SOME ADDITIONAL EXAMPLES SHOWING HIDDEN LINES





EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Hidden Lines

Review page 4 of Lesson 1. Then, in the space below, with a ruler, draw an example of a hidden line. Make sure you are using the correct pencil, and that the dashes are properly spaced.

EXERCISE 2: Hidden Edge Lines

Circle the correct words in the following pairs:

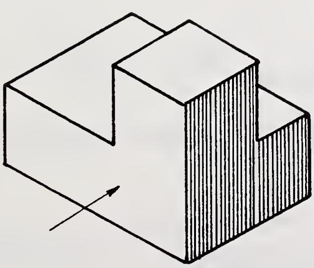
1. A hidden outline is made up of (short, long) dashes (evenly, unevenly) spaced. For the line to be (light, heavy), it (is, is not) heavied up with the H pencil.

2. Where a hidden line meets a visible object line, the dash (should, should not) meet the solid line.

3. Where two hidden surfaces meet, the two sets of dashes (should, should not) meet.

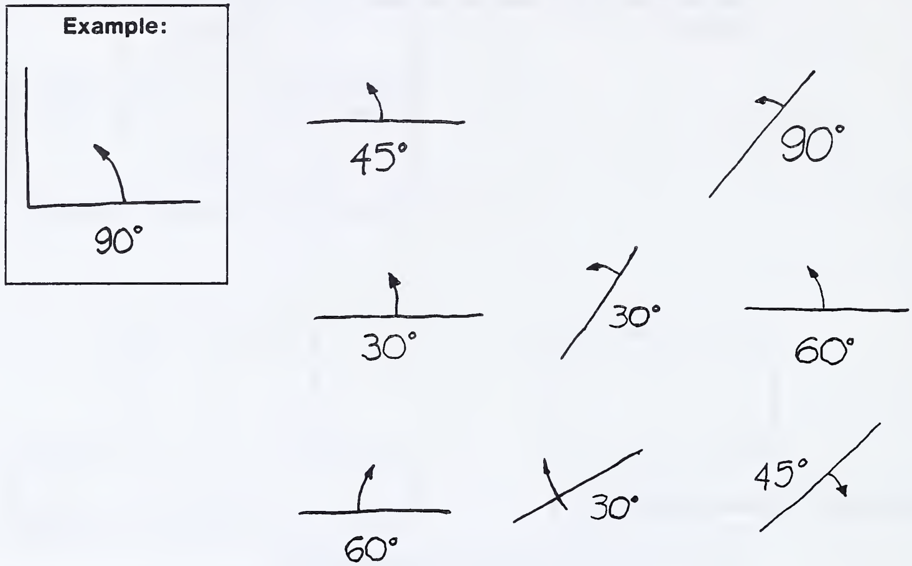
4. When a visible outline is a continuation of a hidden outline, the dash (should, should not) meet the solid line.

5. In the space to the right of the object below, sketch the face indicated by the arrow, as a front view, showing all hidden lines required correctly drawn.



EXERCISE 3: Sketching Angles

1. In the space below complete a sketch of each angle ABOVE the arm already drawn as indicated by the arrow. Estimate the size of the angle. Do not use any measuring instruments.



2. Below each heading sketch at least three angles of approximately the size called for in the heading. Make some of the angles so that neither side is horizontal nor vertical. Do not use any measuring instruments.

30° 45° 60° 90°

EXERCISE 4: Drawing Inclined Lines and Parallel Lines

1. A triangle can be used with the aid of a T square for drawing vertical lines. (Answer "True" or "False.") ____________

2. To draw a line 75° with the horizontal, place the ________________ triangle against the T square and place the ________________ triangle against the first triangle. (State the type of triangle that you use in each case.)

3. Why are inclined lines drawn in the direction shown in the figures on page 4?

____

____

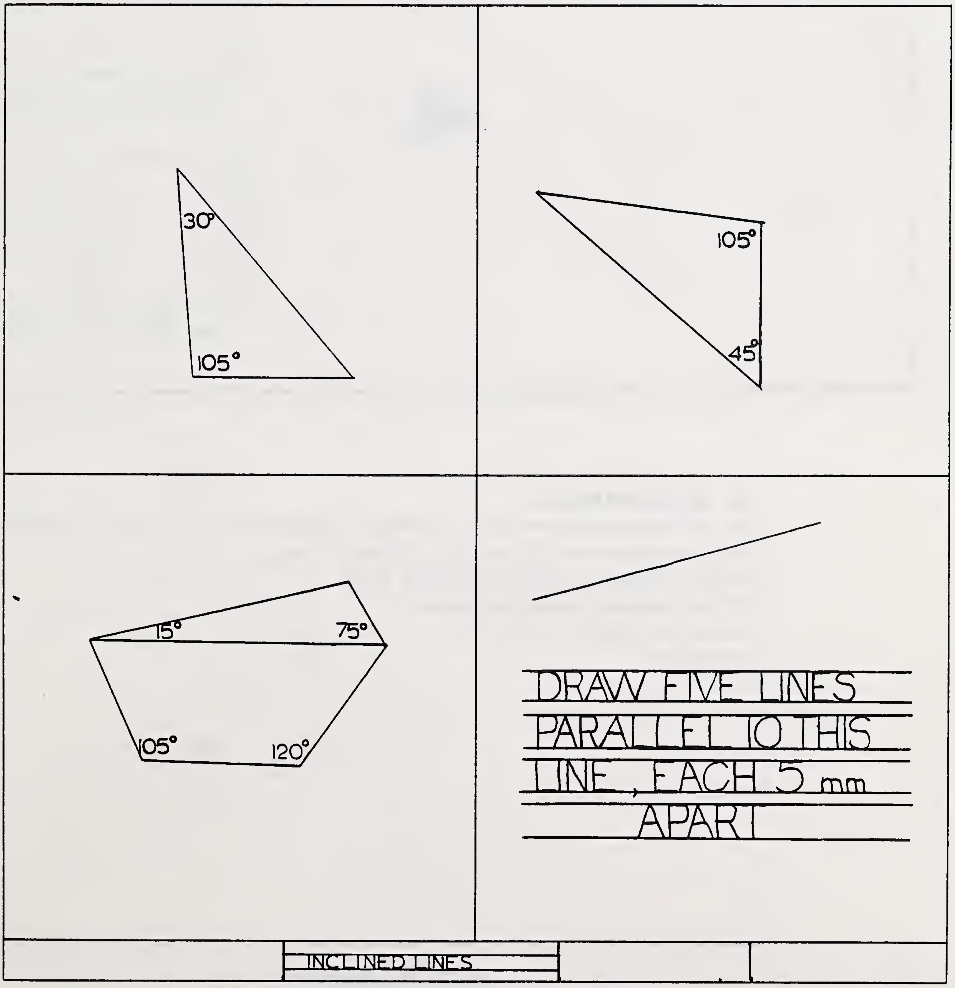
4. Lines can be drawn parallel to a line that has already been drawn by using a triangle and T square. (Answer "True" or "False.")

____

5. If you have only three or four closely spaced parallel lines to draw, it would be easier to use another triangle for a guide instead of the T square. (Answer "True" or "False.")

____

6. Attach a sheet of drawing paper on your drawing board and prepare a plate. Use a T square and triangles to draw the following figures. Use your own judgement as to the sizes of the figures but try to make them large enough so that no line is less than 50 mm long. The angles illustrated below are not drawn the correct sizes.



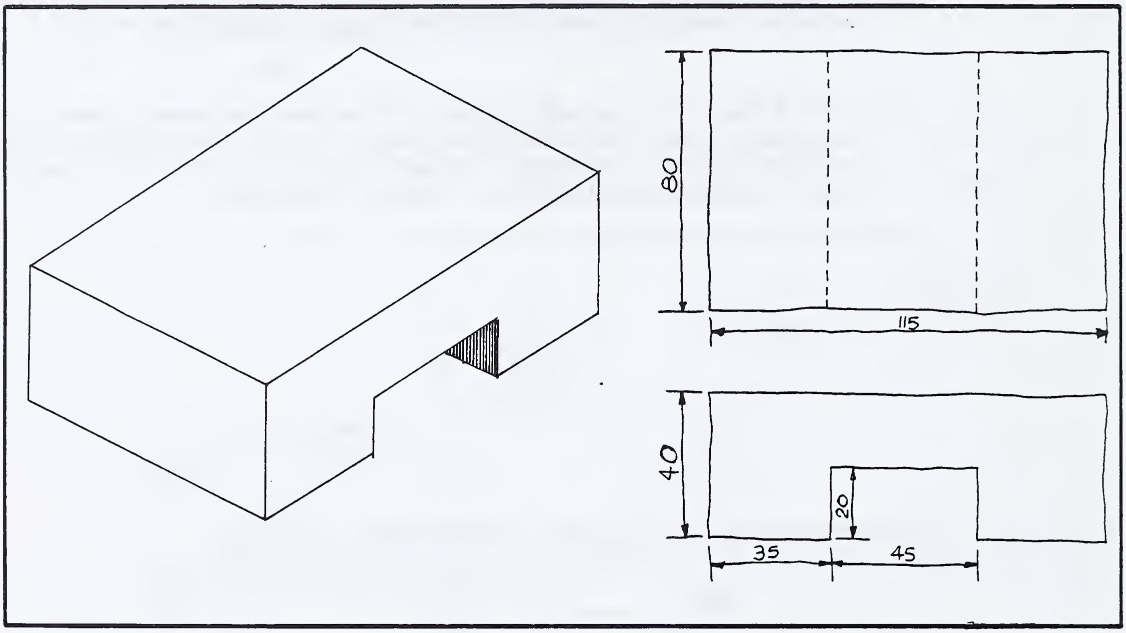
EXERCISE 5: Hidden Lines in Orthographic Drawing

The following drawings are to be done on prepared plates and centred as outlined in Lesson 5. this time you will have to decide for yourself which views to draw, except in the first drawing.

Draw all objects full scale.

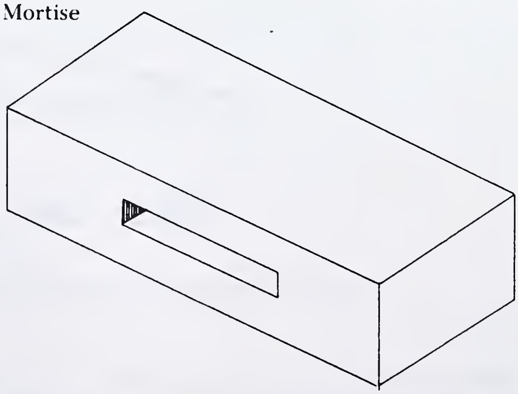
1. Channel Block

From the two-view sketch we have drawn, make a finished working drawing properly centred on your plate.



2. Mortised Block

Outside dimensions, 30 × 50 × 126 mm. Mortise in the centre of the piece, 8 × 50 × 50. (Front view and one other. Make a freehand sketch of the views first.)



END OF LESSON 6

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

____

(If label is missing
or incorrect)

File Number

____

Lesson Number ____________

FOR SCHOOL USE ONLY

Assigned
Teacher: ________

Lesson Grading: ________

Additional Grading
E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ______

Date Lesson Received:

____

Lesson Recorded ______

Student's Questions and Comments

Apply Lesson Label Here

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Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

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ALBERTA DISTANCE LEARNING CENTRE

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do not enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

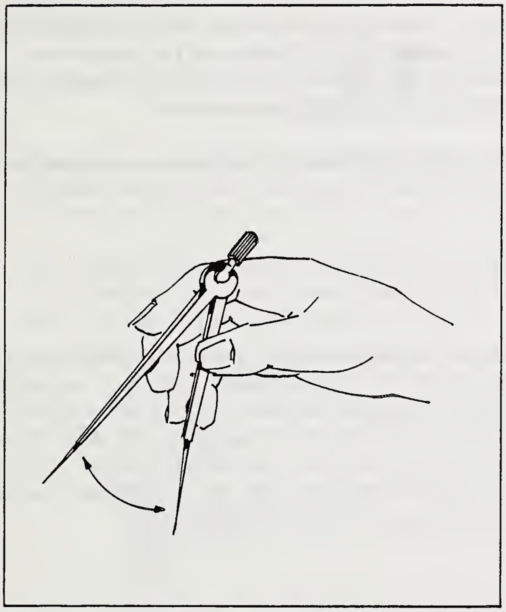
Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.

Try to mail each lesson as soon as it has been completed.

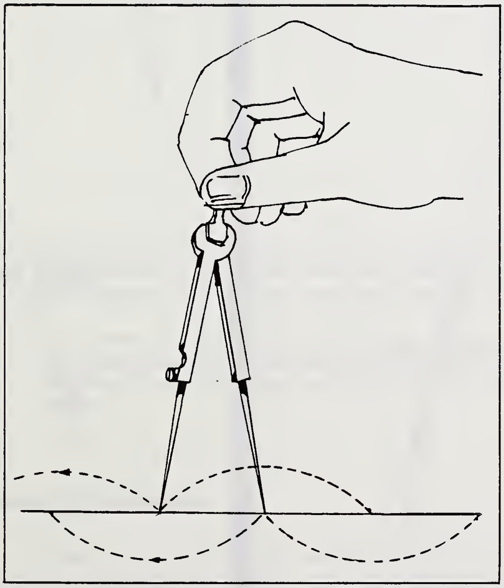
When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

USE OF DIVIDERS AND COMPASSES; BISECTING LINES, SKETCHING CIRCLES

Use of Dividers



OPEN AND CLOSE THE DIVIDERS WITH THE FINGERS



SWING THE DIVIDERS FROM ONE SIDE TO THE OTHER

Every set of drawing instruments contains dividers as well as compasses. The dividers resemble compasses closely but instead of one leg ending in a pencil or pen point, both legs end in a steel point. Obviously then, dividers are not used for drawing circles. Although it is not essential that you have dividers for this course, they are very useful and if you do have them by all means make as much use of them as you can.

As the name implies, dividers are intended for dividing distances into a number of equal parts. But more frequently you can use them for marking off distances. (In fact, there are better ways of dividing distances than by using dividers so we shall not discuss here their use for that purpose.) For instance, if you are ruling guide lines for lettering, you can measure the width between the first pair with your scale. Then for all remaining pairs just open the dividers to the width of the original guide lines, and mark off succeeding widths with the dividers (taking care that the line between the divider points is perpendicular to the guide lines to be drawn).

The dividers indicate points by piercing the paper with their prongs. When the point is pressed through the paper the pin prick may be scarcely visible to the eye, so a light pencil dash through it or a circle around it should be made.

When equal divisions are to be marked off on a line, set the dividers to the required width, then press the points through the paper along the line starting at one end. Always keeping one, then the other, point stuck in the paper, swivel the dividers about the line, alternately on one side then the other as shown in the illustration, until the divisions are completed.

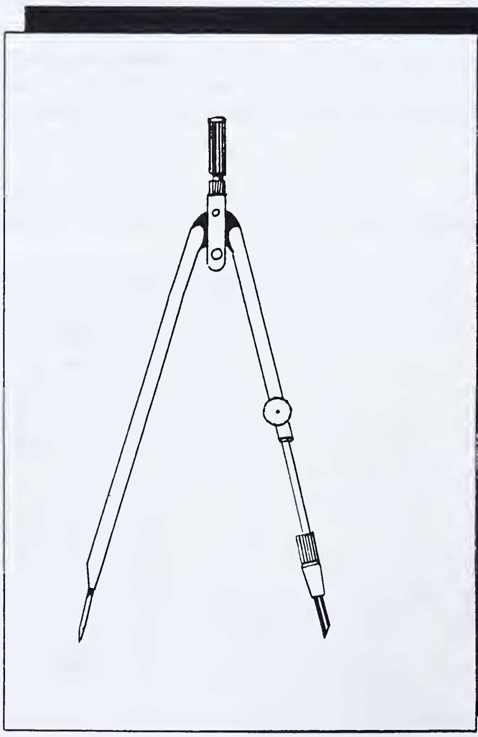
It is better to use dividers than a scale for marking off equal divisions, because you have only to make a measurement once when setting the dividers. On the other hand, when a scale is used each time you measure, there is bound to be some error and it is consequently impossible to get all the measurements exactly equal.

The same thing applies when you are making two identical measurements on a drawing or making a copy of a drawing. Set the dividers on the measure to be copied, then transfer them to the new location. If a scale were used you would be measuring with it twice, whereas setting the dividers corresponds to a single measurement.

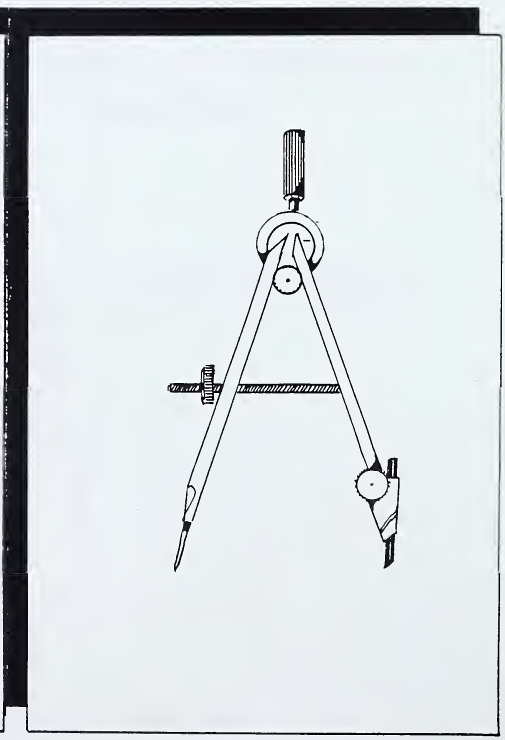
So if you have a pair of dividers use it in preference to measuring with a scale whenever that can be done.

Use of Compasses

A set of drawing instruments usually contains two pairs of compasses, the standard straight-legged compasses and the bow compasses. The bow compasses are used for drawing small circles. The standard compasses are best used for drawing circles that are larger than the bow compasses will handle, or when several circles of different radii are to be drawn in succession. The set screw on the bow compasses enables you to set the radius very accurately, and once it is set it will not shift. Hence the bow compasses can be used for drawing several circles of the same radii in succession.



REGULAR COMPASSES



BOW COMPASSES

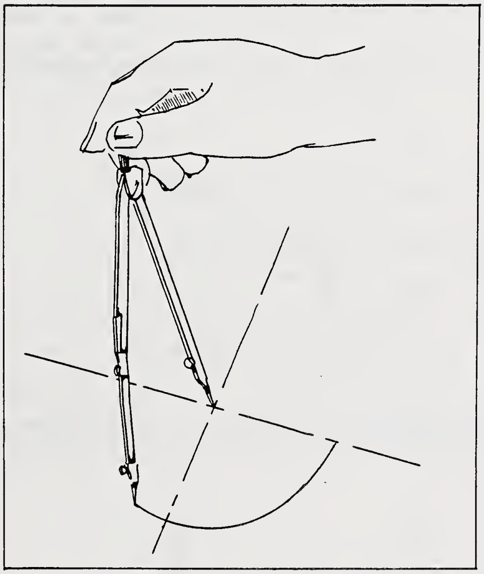
Both types are used in the same way.

1. The lead is dressed to a bevel point as shown below. This is done by holding it slantwise against the sandpaper and rubbing until the bevel is flat across the end.

1. The lead is inserted so that the long edge of the bevel is on the inner side nearer the opposite leg, as shown on page 2. When the legs are brought together, the needle point should extend slightly farther than the pencil lead.

3. The compass point is pressed lightly into the paper at the point where the centre lines of the circle to be drawn, cross. The radius of the circle should be marked off on one of the centre lines. The compass can then be set to this radius.

4.



The compasses are held **LIGHTLY** at the top and turned clockwise while leaning them forward. Do not press downward. The compass lead marks by reason of the instrument's own weight. Pressure will not darken the line but may enlarge the hole made by the point.

5. To increase the blackness of the line the compasses may be rotated around the circle several times in the same direction. Because pressure cannot be exerted on the lead, a softer grade is used in the compasses than is used in your drawing pencils.

NOTE: When setting the radius on the bow compases squeeze the legs together to take the pressure of the bow spring off the set screw, before turning the screw. If the leg is pressing against the screw when the screw is turned the resulting wear on the fine threads of the spindle is apt to eventually strip the threads.

Bisecting Lines by Means of Compasses

To "bisect" means to cut in two. To bisect a line means to cut it into two **EQUAL** parts; not just any two parts.

Compasses may be used for a number of geometrical purposes other than drawing circles. A line may be simply and accurately bisected by using compasses.

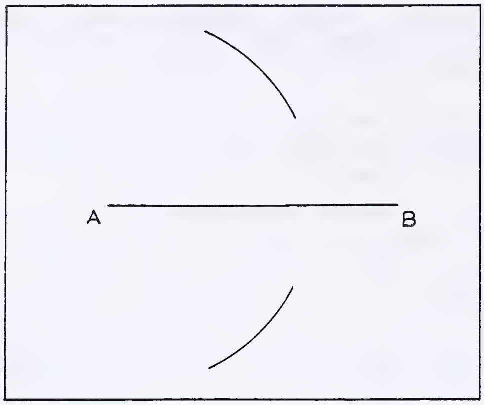
Use standard compasses for this purpose as the radius setting is not critical.

Carry out the following steps.

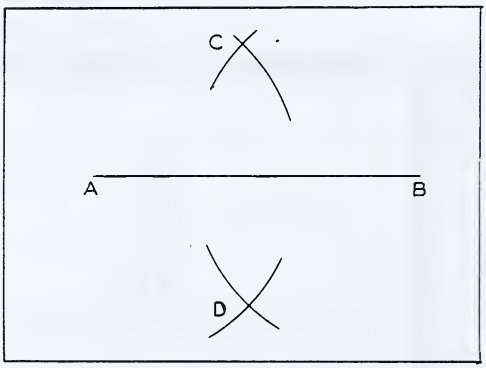
1. 

The ends of the line to be bisected are at A and B.

2. Set the radius of the compasses so that it is considerably greater than half the length of AB, say about 0.75 of the length of AB.

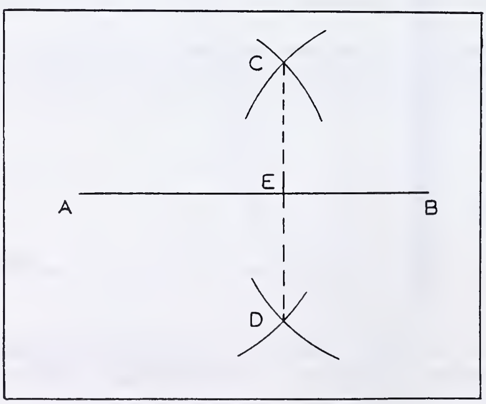
3. 

With the compass point at A draw **TWO** arcs, one on either side of the line so that they pass above and below what you would judge to be the centre of the line.

4. 

Do not change the radius but shift the compass point to B and draw two arcs which cross the first two.

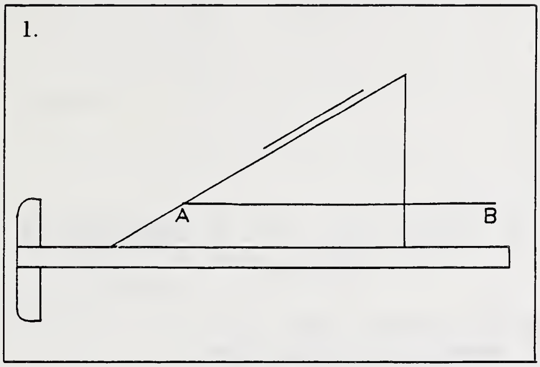
5. Put your pencil point at C and lay the straight edge of a triangle between C and D, swivelling it into position so that it touches a pencil point placed at D.

6. 

Draw a dash where the straight edge crosses AB. This is the centre of AB. The line AB is bisected at E.

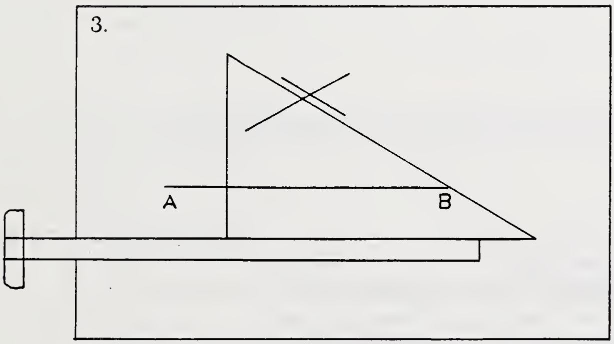
Bisecting Lines by Means of Triangles

A horizontal or vertical line can be bisected very easily by means of a T square and triangle instead of compasses.

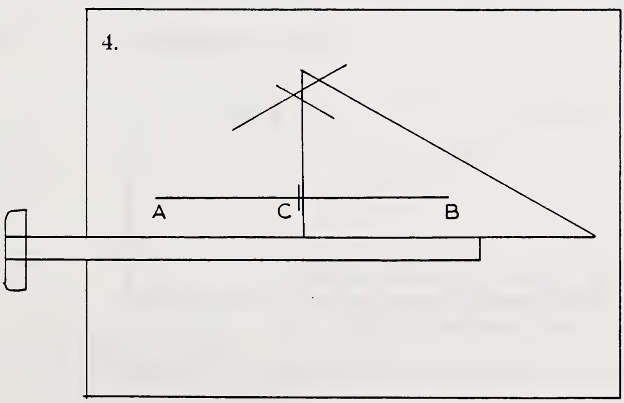


Place a pencil point at A. Lay the triangle along the T square and bring the sloping edge up to the pencil point.

2. Draw a dash along the sloping edge of the triangle above the estimated centre of AB.



Flip the triangle over and repeat the process, placing the sloping. edge against a pencil point held at B.



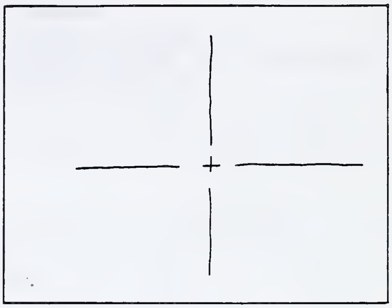
Place the pencil point where the two dashes cross and bring the vertical edge of the triangle up to this. Draw a dash at C where this edge crosses AB. AB is bisected at C.

Sketching Arcs and Circles

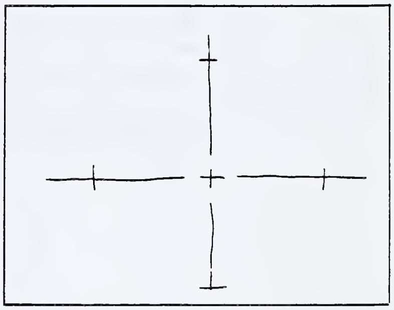
A great many arcs and circles occur in drawings of machine parts. But working drawings drawn with instruments cannot be started until complete details of the drawing have been sketched. You will, therefore, need to be able to sketch arcs and circles as well as straight lines.

To sketch a circle proceed as follows:

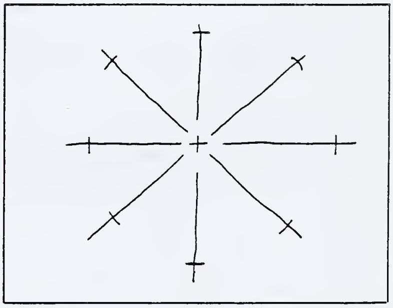
1. To locate the centre of the circle, sketch a horizontal and a vertical centre line.



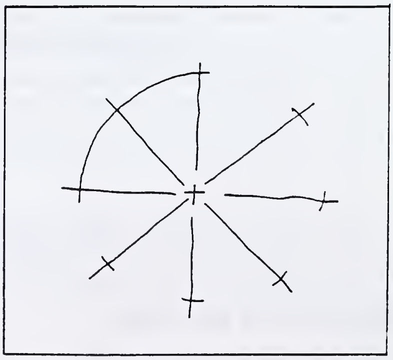
2. On each centre line, on both sides of the centre, mark off a distance equal to the radius of the desired circle. (Estimate the distances—do not measure.)



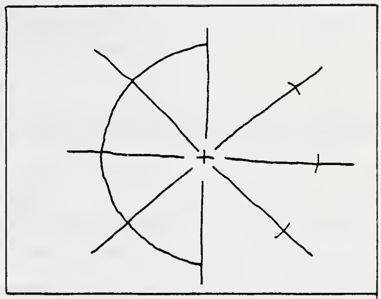
3. If the circle is fairly large, draw lines at 45° to the horizontal. Mark off distances equal to the radius along these lines also. (These may be omitted when you have gained enough skill in sketching circles.)



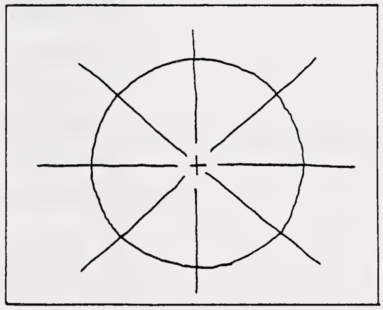
4. Lightly sketch the upper left quater of the circle. The arc should meet the centre lines squarely. Make it as well-rounded as you can.



5. Sketch the lower left quarter in the same way.



6. Now sketch the upper right quarter, and finally the lower right quarter.



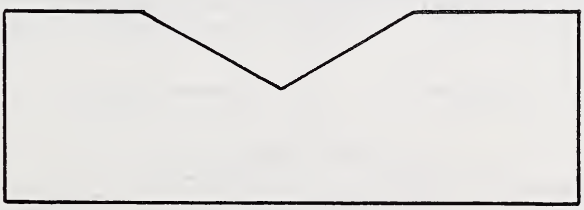
7. True up the circumference where needed. Then heavy up with a clean, smooth line.

Dimensioning Arcs, Circles, Angles

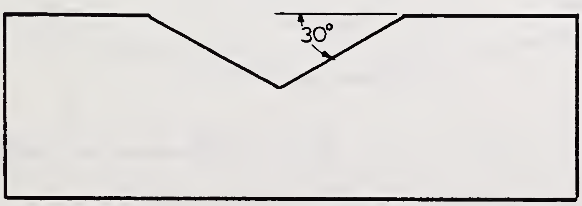
All the arcs and circles you draw on a working drawing will have to be dimensioned.

Review how to dimension arcs and circles as instructed in Lesson 4.

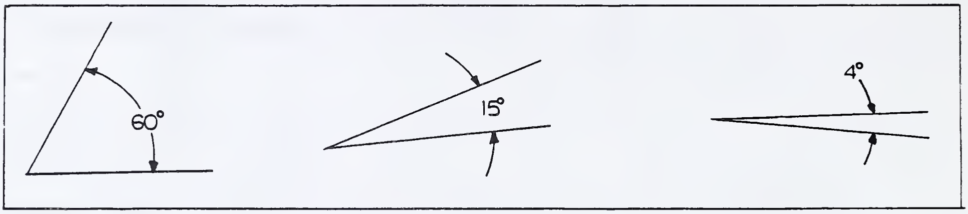
1. Dimensioning Angles



The drawing shows a view of the face of an object which contains a V-notch. It is desired that the sides of the V make an angle of 30° with the horizontal. To indicate this angle we simply use an extension line as we do for any other dimensioning problem. Then in place of a dimension line we use the arc of a circle whose centre is the vertex (meeting point of the arms) of the angle. Note that dimension lines for angles are drawn with compasses and arrowheads are used in the usual manner. Use your judgment as to the radius of the arc so as to get the dimension numerals neatly spaced in the angle.

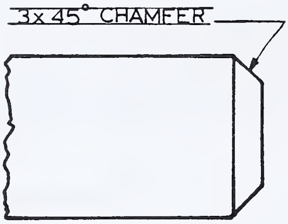


For all small angles, dimension lines can be drawn outside the angle as we do with small widths. Letter the numerals upright, not at an angle.



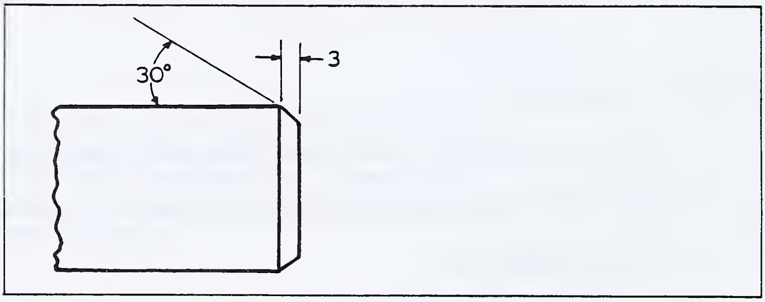
2. Dimensioning Chamfers

A chamfer is a beveled or sloping edge. A 45° chamfer is dimensioned as shown.

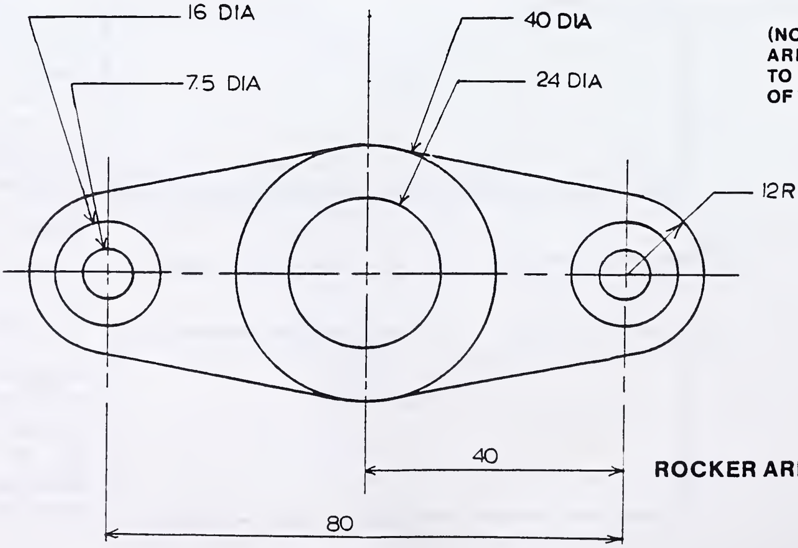


This indicates that the horizontal distance between the edges of the chamfer is 3 mm.

If the chamfer is not 45° then the length and angle are indicated as shown below.



ANOTHER EXAMPLE SHOWING HOW TO DIMENSION CIRCLES AND ARCS



(NOTE HOW ALL ARROWS POINT TO THE CENTRE OF THE CIRCLE.)

ROCKER ARM

EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Use of Dividers and Compasses; Bisecting a Line

1. Why are dividers swung alternately from one side of the line to the other when dividing a line instead of being rotated in one direction only?

____

____

2. How are the pinpoints produced by dividers made visible?

____

____

3. (a) A (compass, divider) should be used to mark off equal divisions.

   (b) What advantage does this instrument have over a scale?

   ____

4. To bisect a line means to divide it into any two parts. (Answer "True" or "False.")

____

5. Why should lead in the compasses be a grade softer than the lead in a drawing pencil for the same weight of line?

____

EXERCISE 2: Sketching Arcs and Circles

Below, sketch four circles of various radii showing the construction lines. (Neither scale, straight edge, nor compasses may be use.)

EXERCISE 3: Drawing Angles and Circles

Write in the correct word.

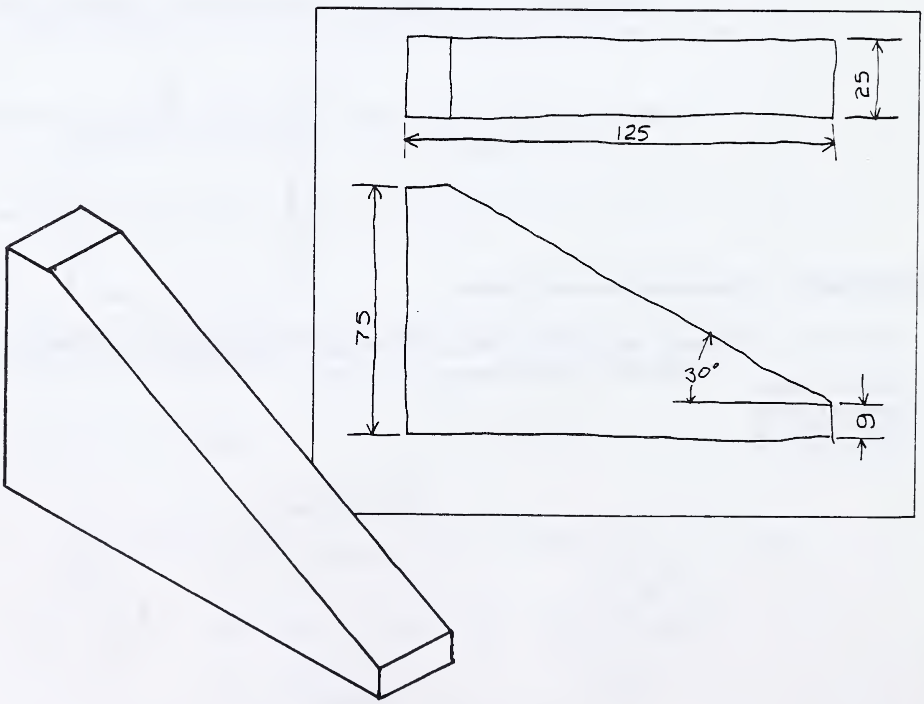
1. An arc is dimensioned by giving its ________________________________.
   (radius, diameter)

2. A circle is dimensioned by giving its ________________________________.
   (radius, diameter)

3. Use a prepared plate for each of the following articles. Include a preliminary sketch for each drawing unless otherwise stated. Show all necessary dimensions. The given angles are all measured from the horizontal. Use a 1:1 scale.

Example: Seat Bracket (Front and Top Views)

(When you are given an angle in an object, state the size of angle as a dimension. Do not dimension the length of the resulting angled line.)



THE ABOVE DRAWING IS JUST AN EXAMPLE. YOU DO NOT NEED TO DO IT. THE FOUR DRAWINGS ON THE NEXT TWO PAGES **DO** NEED TO BE DONE.

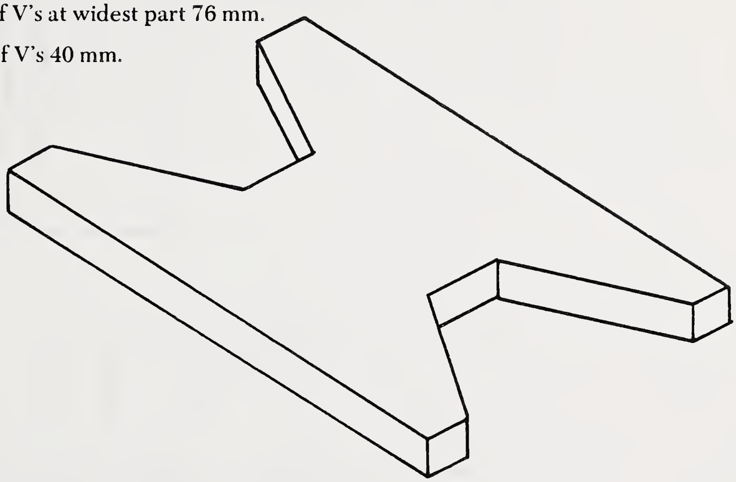
(a) Line Winder (Show any two views but avoid any which required hidden edges to be shown.)

Overall dimensions, 12 × 100 × 150 mm.

Sides of the V's are at 60° to the ends.

Width of V's at widest part 76 mm.

Depth of V's 40 mm.



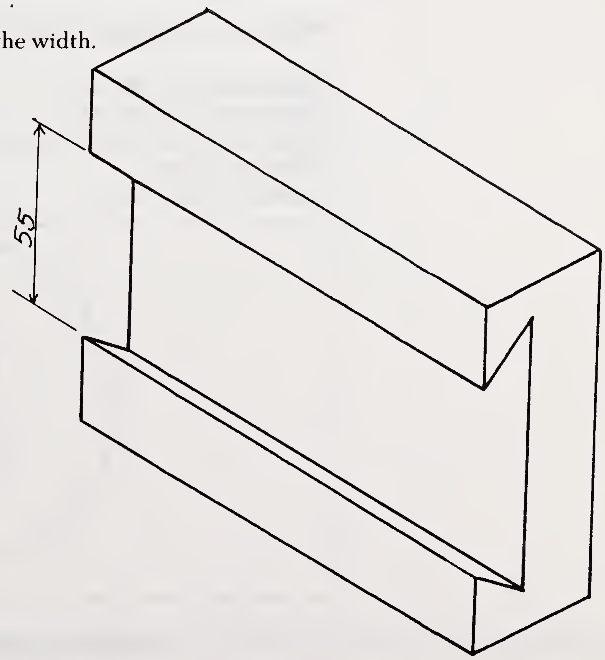
(b) Gibbed Way (Show the front and side views. Indicate all hidden edges.)

Overall dimensions, 35 × 105 × 140 mm.

Width of dovetail at top, 55 mm; depth, 15 mm.

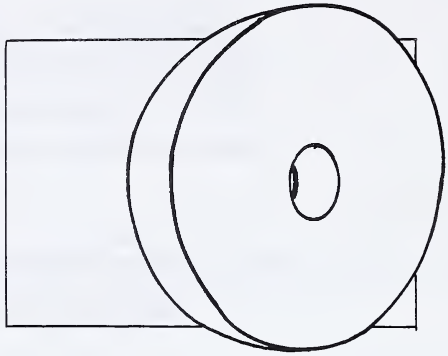
Angle of dovetail, 45°.

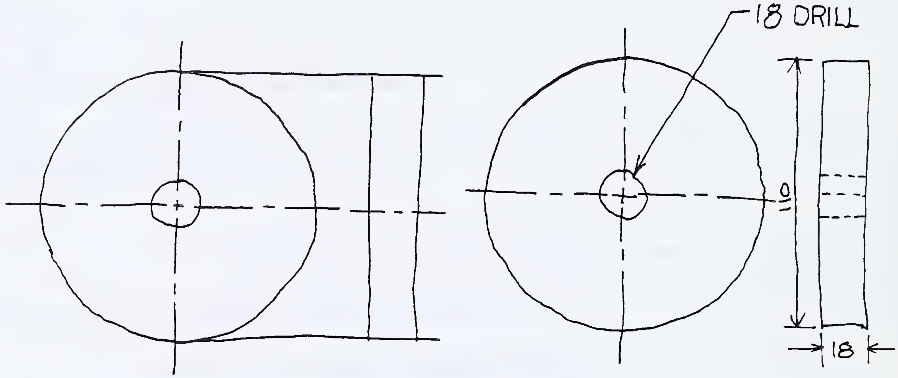
Dovetail centred in the width.



(c) Wooden Wheel (Show the front and side views. Omit the sketch.)

Diameter, 110 mm.
Thickness, 18 mm.
Drill 18 mm hole in centre.

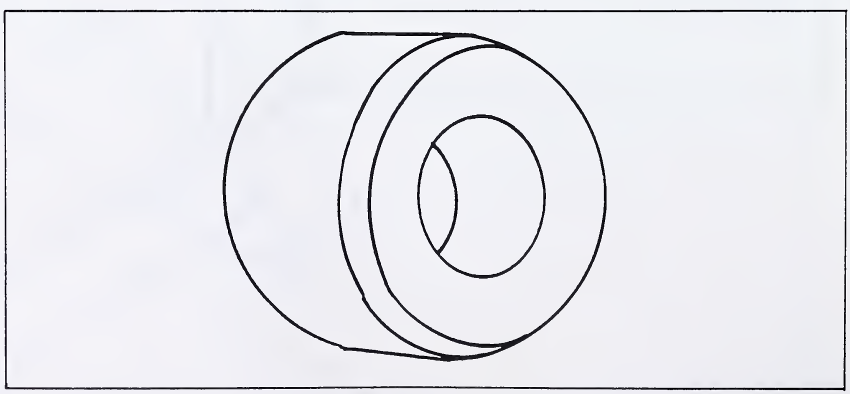




(d) Ink Bottle Holder (Show any two views.)

NOTE: In all problems which include circles, the centre lines must be drawn.

Outside diameter, 96 mm.
Diameter of hole, 50 mm.
Depth of hole, 15 mm. (Note that the hole does **NOT** go all the way through.)
Thickness, 25 mm.
Chamfer, 6 mm × 45°.



END OF LESSON 7

LESSON RECORD FORM

1715 DRAFTING 10

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Lesson Number ____________

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Assigned
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Lesson Grading: ______

Additional Grading
E/R/P Code: ______

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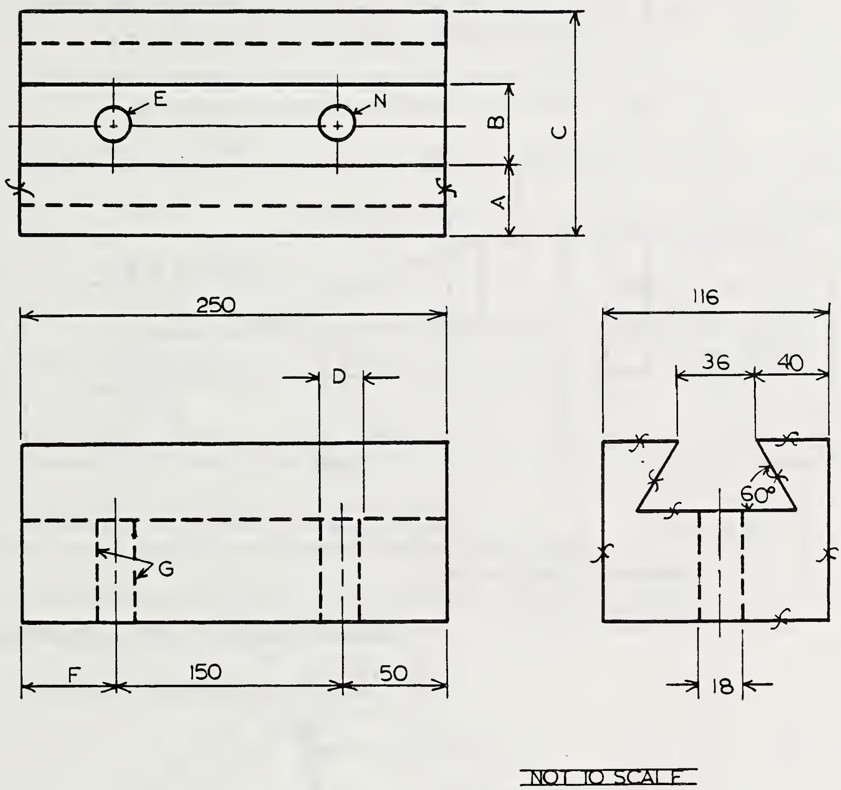
MORE ABOUT FINISHED SURFACES



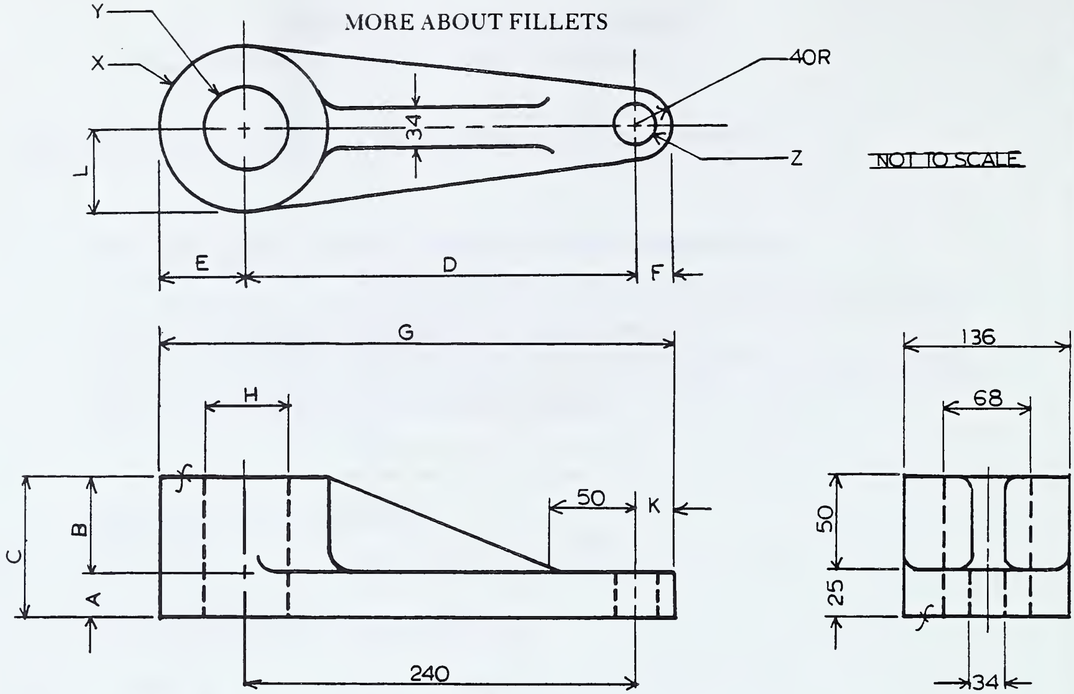
MACHINED BLOCK

You have learned in Lesson 4 that finished surfaces were surfaces that are machined to a smooth surface. Such surfaces are indicated on blueprints by the symbol ƒ which appears on each edge line of the surface to be finished. In modern practice the symbol $\vee$ may be used instead, its vertex resting on the edge line $\underline{\;\vee\;}$.

When all surfaces of a metal part are to be finished, these symbols may be omitted and instead a note with the words "finished all over," or FAO , is lettered in the lower portion of the plate.

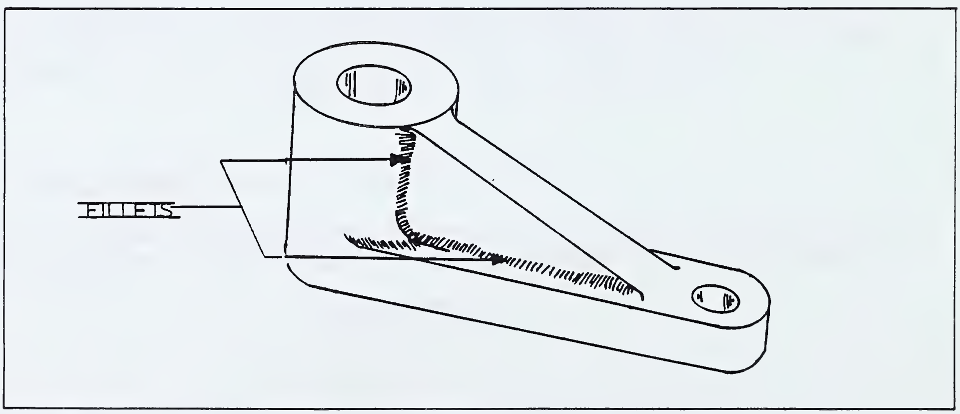
In the drawing of the machined block above, the ƒ symbols could be left out and the FAO note used instead.

MORE ABOUT FILLETS



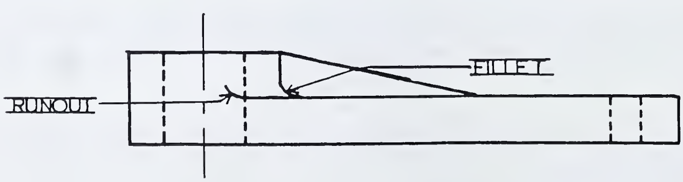
LEVER

In a casting, a fillet needed between the cylindrical portion and the flat portion and the object would look like this:

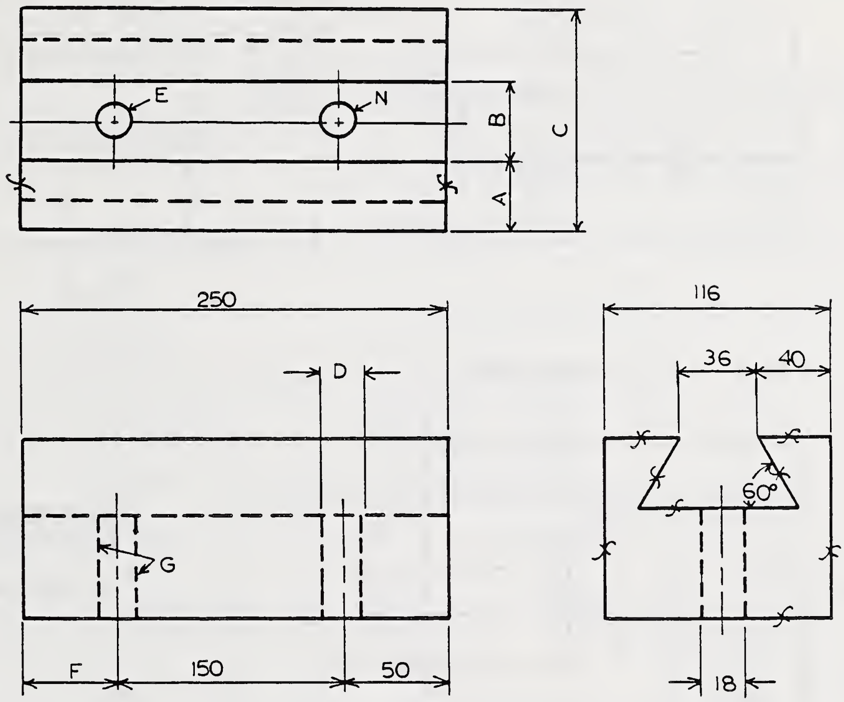


The fillet between the cylinder and flat surface is shown in the front view by means of a small curve called a **runout**.

The front view, showing the fillet drawn correctly, looks like this:



EXERCISES TO BE SENT IN FOR CORRECTION



1: SLOTTED BLOCK

NOT TO SCALE

EXERCISE 1: Blueprint Reading (Refer to figure 1 above.)

1. Determine the following dimensions:

A =	D =
B =	E =
C =	F =

2. The diameters of the holes E and N are ____________________.

3. What does the f symbol on the right side view mean?

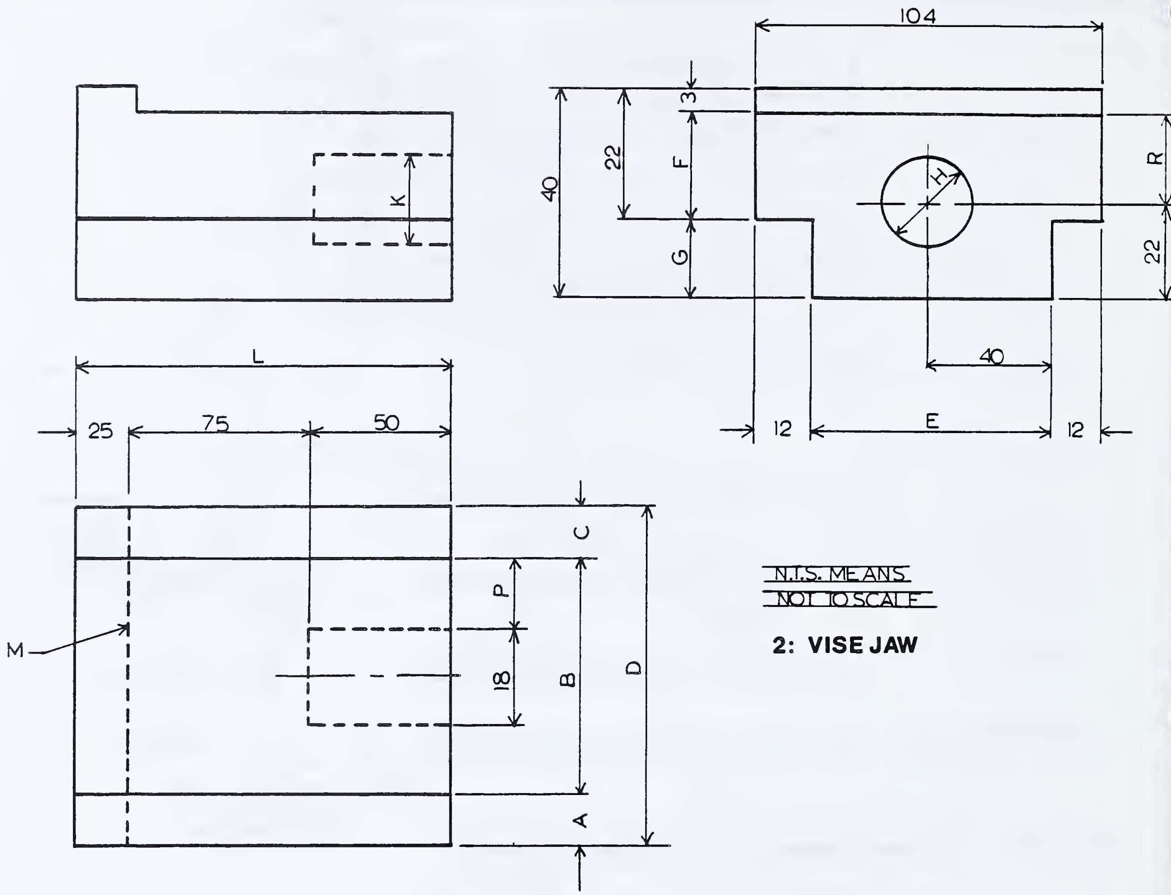
____

____

____

4. What other symbol could be used instead of f ?

____



2: VISE JAW

EXERCISE 2: VISE JAW

1. The depth of hole H is ______________.

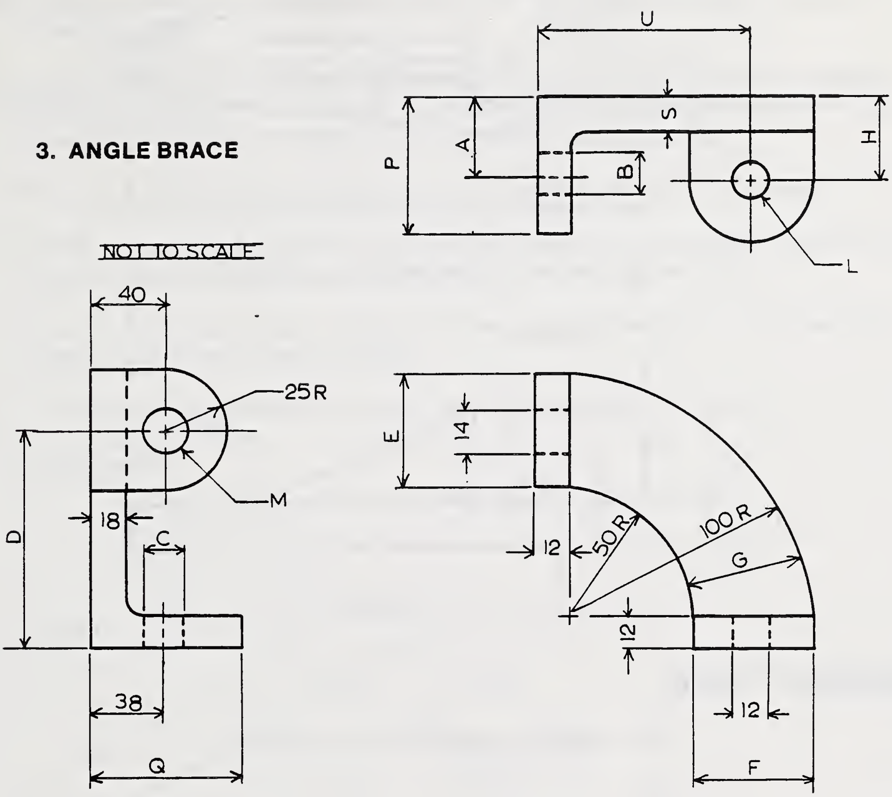
2. What 3 views are shown in the drawing above?

   ______________________ view plus ______________________ view

   and ______________________ view.

3. What does N.T.S. means? ______________________

A =	E =	K =
B =	F =	L =
C =	G =	P =
D =	H =	R =



EXERCISE 3: ANGLE BRACE

(It may be a good idea to review Lesson 3 in which it is discussed how to project from one view to the next, before starting this exercise.)

1. The diameter of hole L is _______ ; of hole M is _______ .

A = E = P =

B = F = Q =

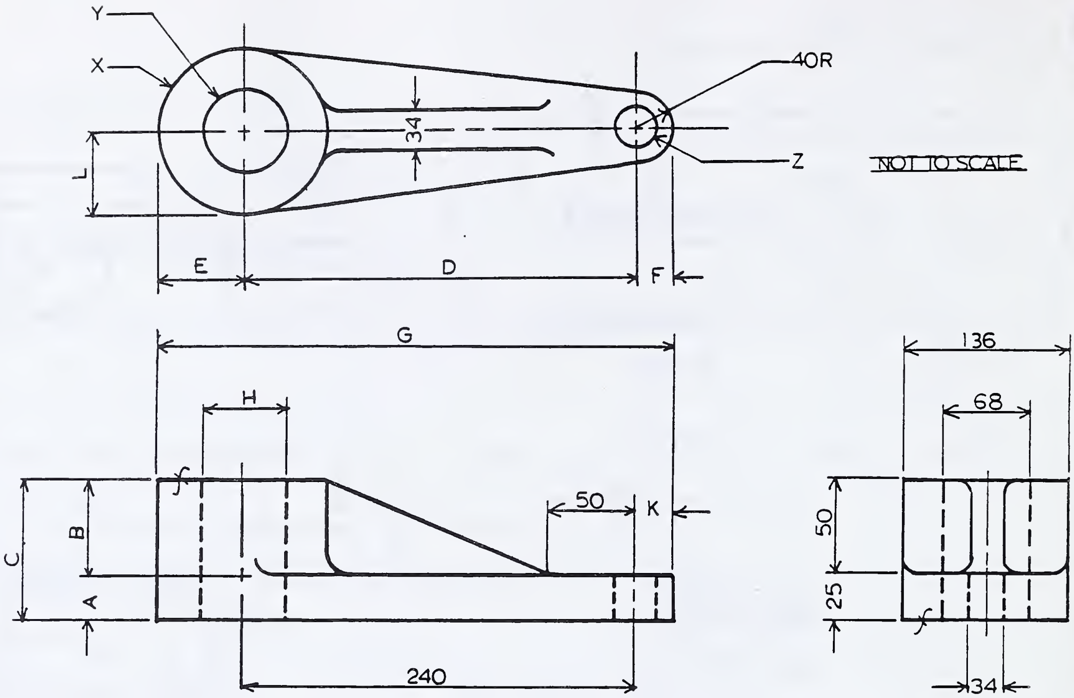
C = G = S =

D = H = U =

3. Name the three views shown: ______________________________ ,

______________________________ , ______________________________ .

4: LEVER



EXERCISE 4: LEVER

1. The diameters of the following circles are:

X =　　　Y =　　　Z =

2. A =　　　E =　　　K =

B =　　　F =　　　L =

C =　　　G =

D =　　　H =

3. The number of faced (or finished) surfaces is ____________________.

4. Sketch the portion of the front view which contains a runout.

EXERCISE 5: More Practice in Orthographic Drawing

1. Try the sketches first on scrap paper. Use the 45° line to help you project from the Top to the Side view.

2. Draw **THREE** views of each object. The Top, Front, and Right Side views should be properly lined up in reference to each other. (The front view is given for reference. Copy it and draw the other two views.)

3. Use the squared paper provided and make all drawings without instruments.

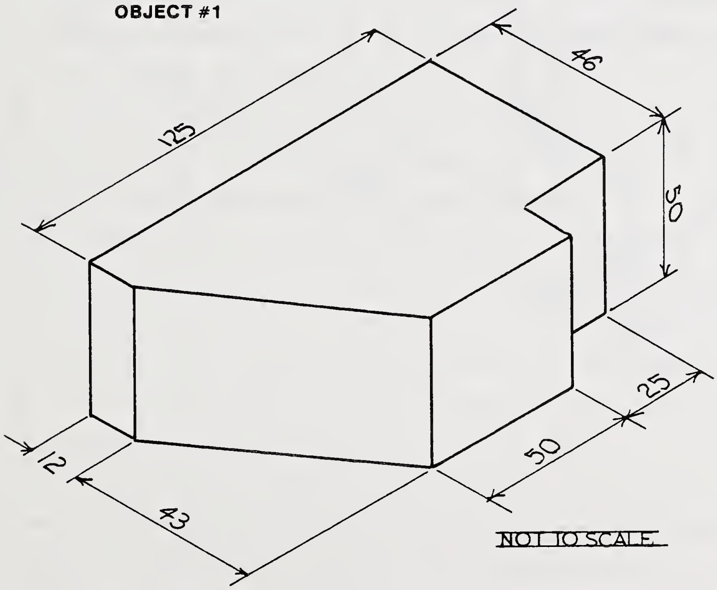
4. Choose a scale which will allow you to put the drawings for both objects on one sheet of paper. Make all lines the correct length for the scale you are using.

5. Show all dimensions needed to give a workman enough information to make the object, using correct dimensioning procedure.

6. Letter on each DRAWING, the title of the object.

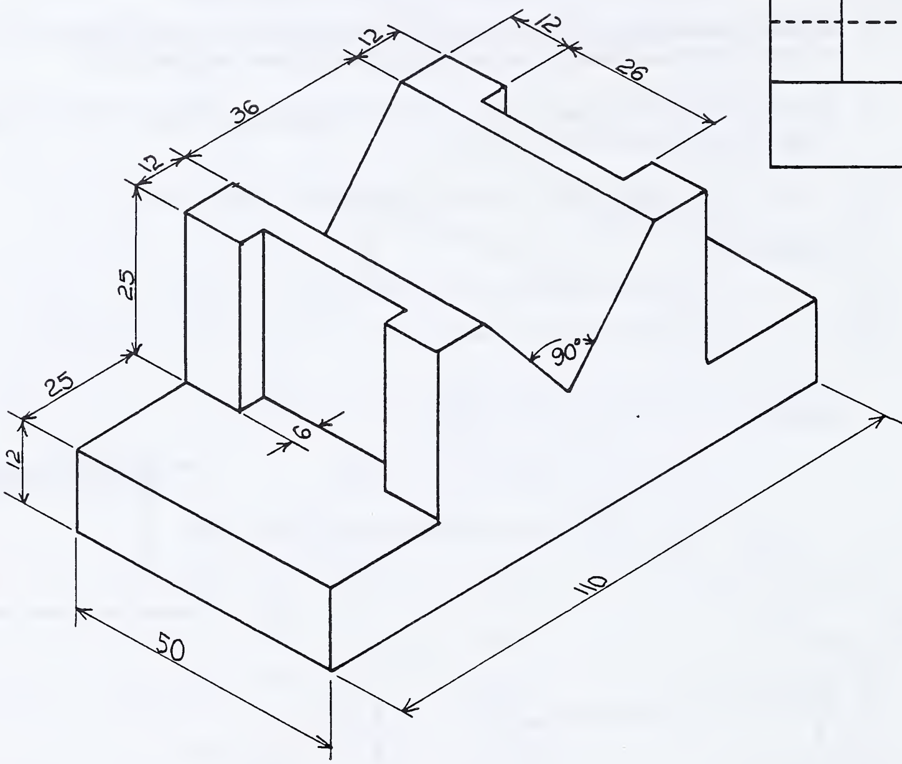
JAW BLOCK

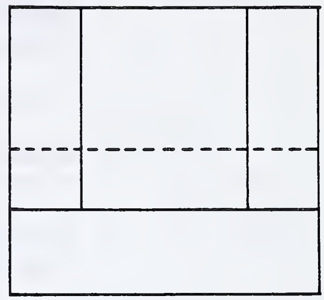
OBJECT #1



V BLOCK

OBJECT #2 NOT TO SCALE





END OF LESSON 8

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DRAWING TANGENT LINES AND ARCS

In order to avoid the need for repeating the word "straight" in this lesson, and for clarity we shall agree to the following:

By "line" we always mean "straight line."

By "curve" we mean any smooth line, parts of which may be either straight or arcs of circles.

By "circle" we mean the circumference of a circle.

By "arc" we mean any portion of the circumference of a circle.

By "radius of arc" or "centre of arc" we mean the radius or centre of the circle of which the arc is a part.

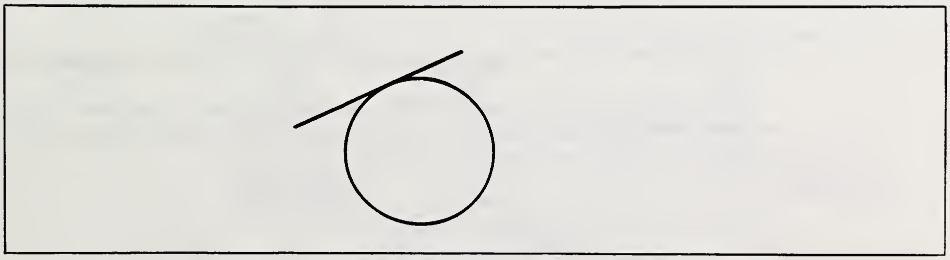
Meaning of "Tangent"

A tangent is a geometrical idea which has many important applications in mechanical drawing. If we draw a twisting curve freehand then it is very easy to make the curve smooth throughout just by running the pencil continuously along the paper like this:

However, to draw this curve with instruments, it would be necessary to break it up into a succession of lines and arcs so that the lines could be drawn with a straight edge and each arc could be drawn with compasses. Each arc would have a different radius and centre. Wherever a line or arc joined or two arcs joined we should have a **point of tangency** because the lines and arcs run smoothly into each other.

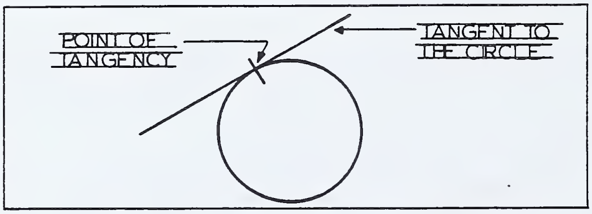
A line is drawn with a straight edge (the top edge of the T square or any outer edge of a triangle). A circle or arc is drawn with compasses.

Let us first, then, consider the idea of "tangent" in relation to a line and a circle. If you place a ruler along the side of a can, the line of the ruler "is tangent to" the circumference of the end of the can, thus



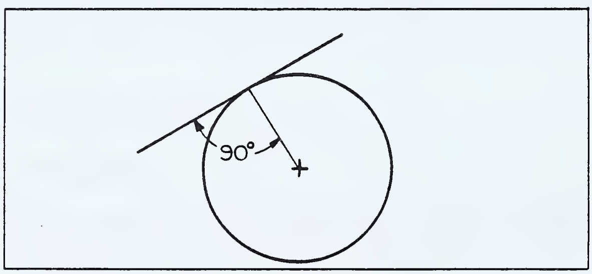
It is obvious that the ruler touches the can. It does not pass through the can.

A line is a tangent to a circle, then, if it touches the circle at one point only. This point is called the **point of tangency**.

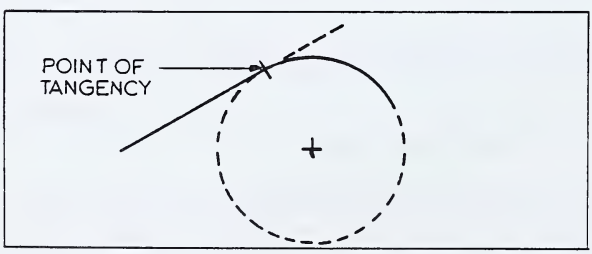


A RADIUS DRAWN FROM THE POINT OF TANGENCY TO THE CENTRE OF THE CIRCLE MEETS THE TANGENT AT RIGHT ANGLES.

It is very important to remember this fact. (This fact is proved in the study of geometry.)

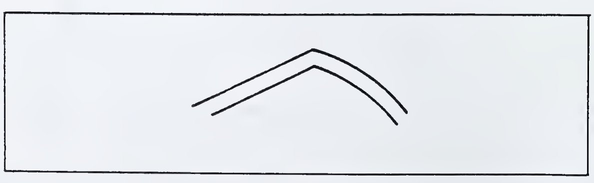


To return to the idea of lines and curves meeting smoothly at the point of tangency, consider the curve that results if we discard the portions of the line and circle beyond the point of tangency, one on either side of the point, like this:

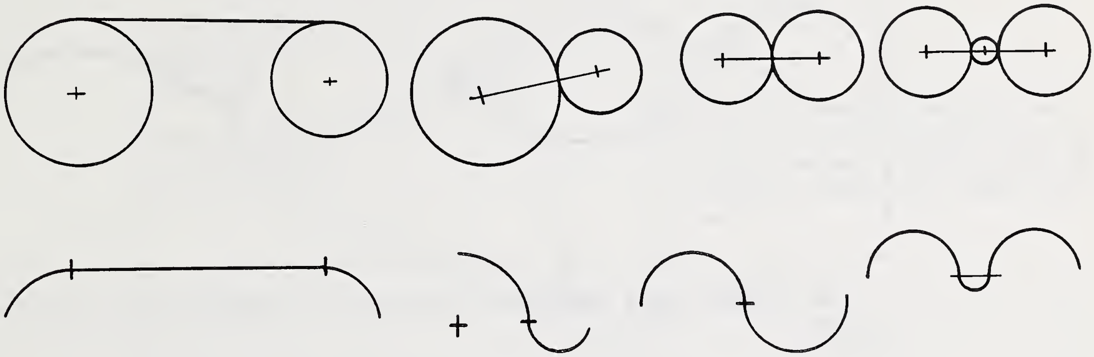


For a smooth curve, then, the line and circle must meet at the point of tangency.

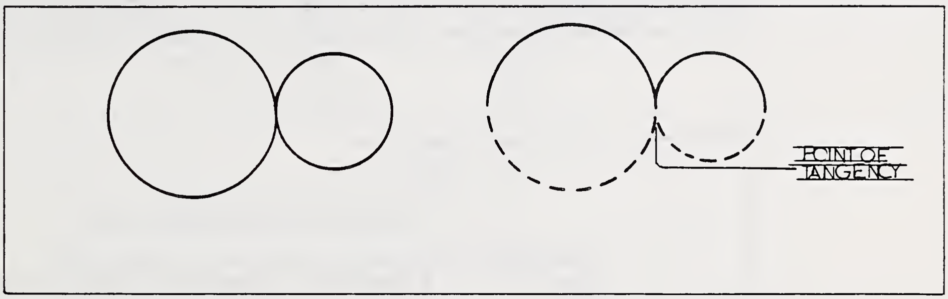
Consider a railway track which runs straight and then must round a curve. If the surveyors did not determine the point of tangency correctly, the line might run like this:



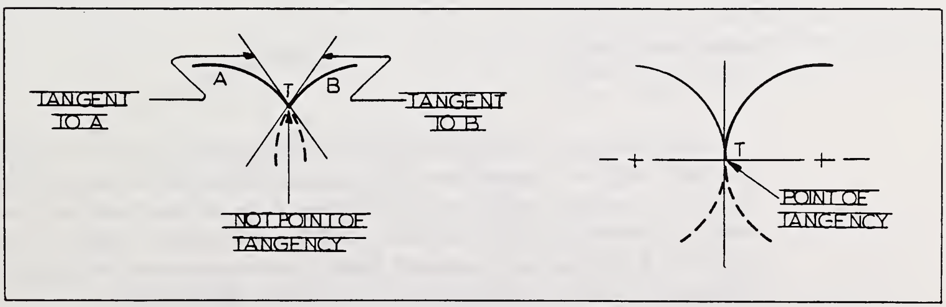
As with lines and circles or arcs, so the same occurs with arcs which meet. For a smooth curve to result they must meet at the point of tangency.



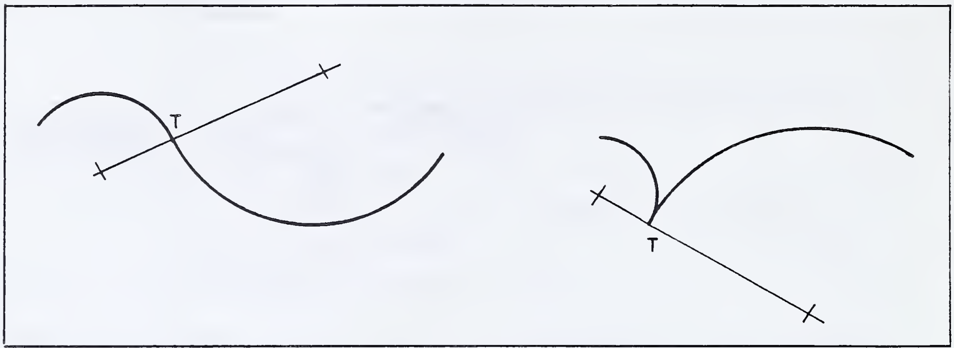
However, when two curves touch at their point of tangency, we can also consider the effect of discarding the portions of the curves both on the same side of the point of tangency, like this:



In such cases each curve shares a common tangent line.



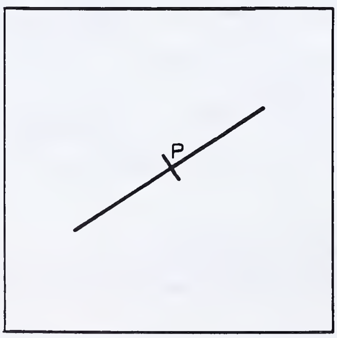
If two arcs meet at their point of tangency, then the line joining their centres passes through the point of tangency.



The examples above illustrate for you the ideas of tangent, tangency, and point of tangency.

How to Draw a Circle Tangent to a Line at a Given Point

In a previous lesson we found that is was possible to draw the right bisector of a line either by using compasses, or by using a T square and triangle (or two triangles). Many construction problems can be done either by means of compasses or by using triangles. Since triangles are simpler to handle than compasses, we shall describe the triangle and T square method in preference to the compass method. Please remember that a second triangle can always be used in place of the T square wherever a triangle and T square are used.



Given: Line with a point P on it.

Required: To draw a circle through P, tangent to the line.

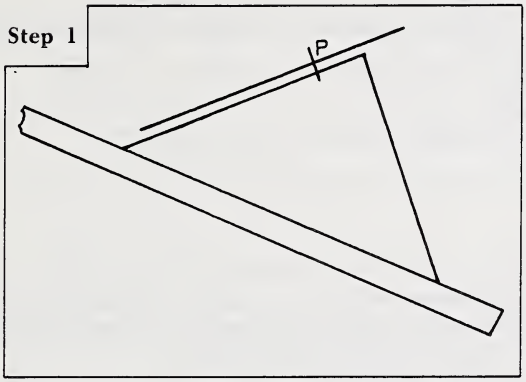
Theory required: A radius of the circle forms an angle of 90° at P with the tangent line.

Using this theory you might think that all you need to do is lay a triangle on the line with the right angle at P, then draw a line along the other side of the right angle which extends from P. As we have said in previous lessons, there is a best way of doing things practically with the instruments. The practical objection to this plan is that the point of the triangle placed at P is bound to be rounded slightly, so there is no way of placing your pencil point at P and setting your triangle against it in exactly the right position.

To overcome this difficulty we proceed as follows:

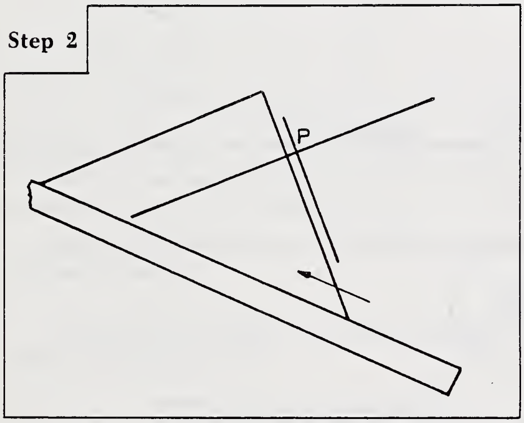
CAUTION: The 4H pencil used must be kept very sharp at all times by briefly rubbing it on your sandpaper block.

Step 1



Place the triangle along the line as shown and place the T square (or long edge of second triangle) against its long edge. Note the 90° angle at the line.

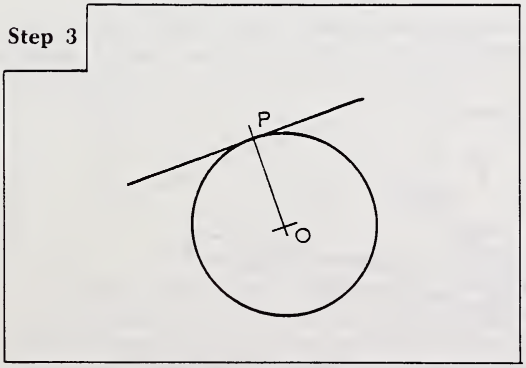
Step 2



Shift the triangle to the left until it clears point P, then place the pencil point on P and press the triangle against it. Draw the line through P which will be perpendicular to the given line.

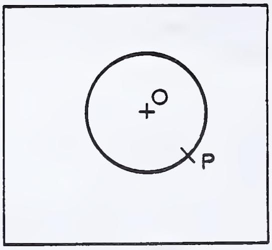
The centre of the required circle will be along this line.

Step 3



Mark off the required length of radius, OP, along this line and draw the circle setting the compass point on O and radius width OP.

How to Draw a Line Tangent to a Circle at a Given Point on the Circle



Given: Circle with centre O and point P on it.

Required: To draw the tangent line to this circle which passes through P.

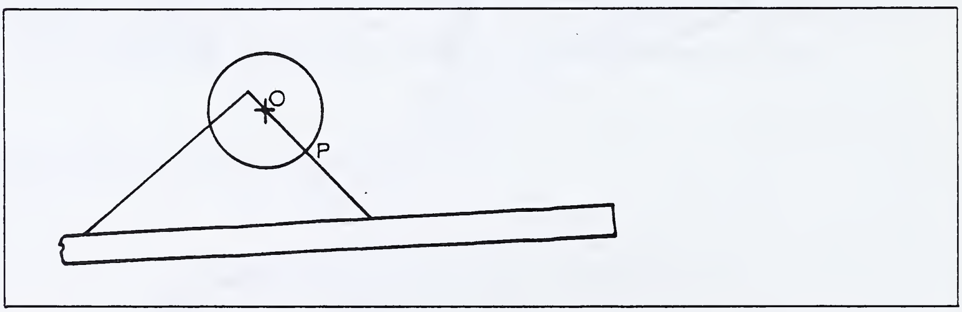
Theory required: The tangent line makes an angle of 90° with OP at P.

What is the practical objection to laying a triangle on OP with the right angle at P and then drawing a line along the other side of the triangle which extends from P? The corner of the triangle may be worn which would give an incorrect line.

Follow these steps instead.

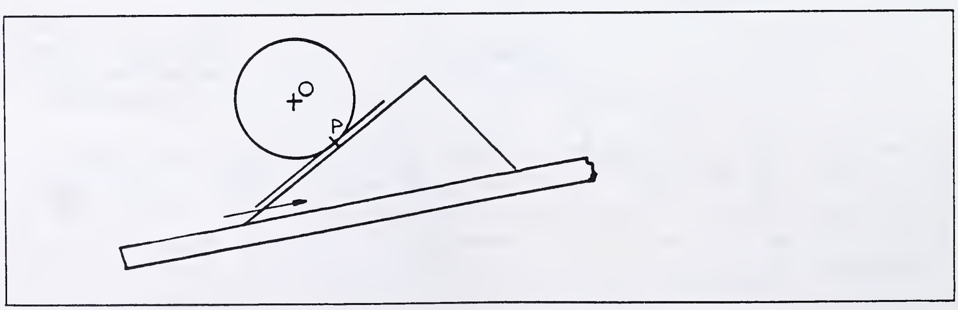
Step 1

Set the side of the triangle along OP and set the T square along the longest edge of the triangle.



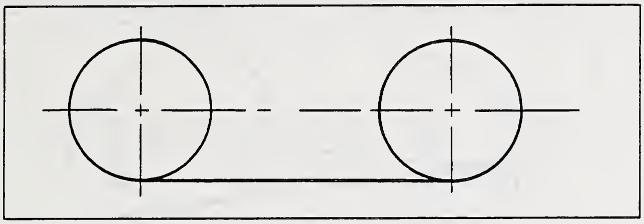
Step 2

Slide the triangle to the right along the T square until it clears point P. Put the pencil point on P and press the triangle against it. Then draw the required tangent line as shown.

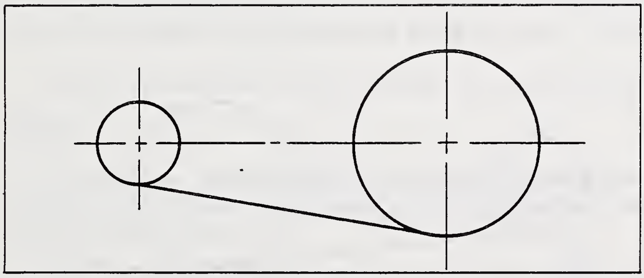


How to Draw a Line Tangent to two Circles

The problem is easy if both circles have diameters of the same length, as shown.

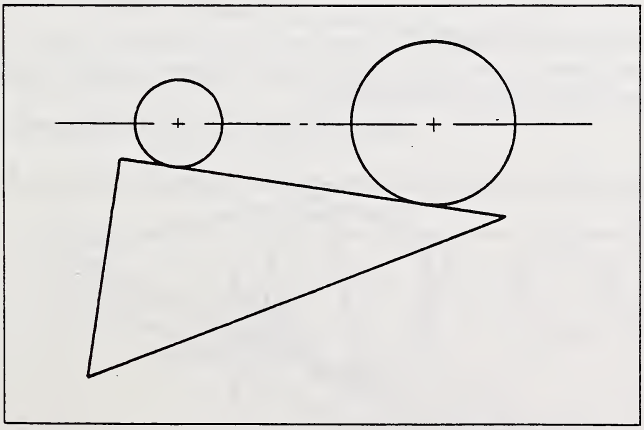


However, if the diameters are different, it is obvious that the following is wrong.



Even if the diameters are only slightly different, the radii from the points of tangency will not be parallel.

One can lay a triangle or T square along the circles and adjust it by inspection until the edge touches both circles.

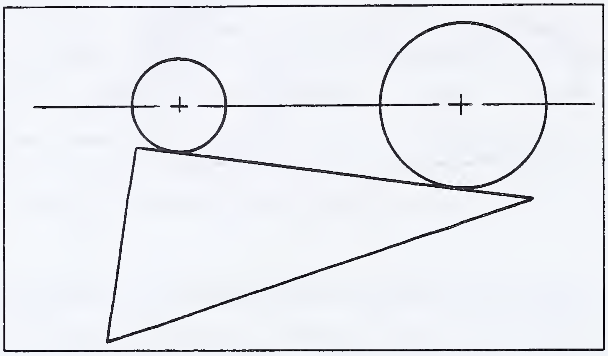


However, the triangle would have to be shifted slightly away from the circles to allow for the thickness of the pencil tip. Also, it is impossible to see the exact point of tangency since the line blends into the circle. The point of tangency needs to be known so that you know where to stop ruling along the straight edge and where to stop turning the compasses.

A good practical way to draw the tangent line is as follows:

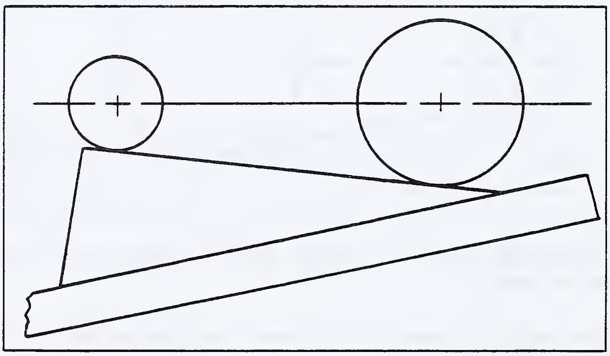
Step 1

Lay the triangle along the circles as shown, adjusting it by inspection to just touch both circles.



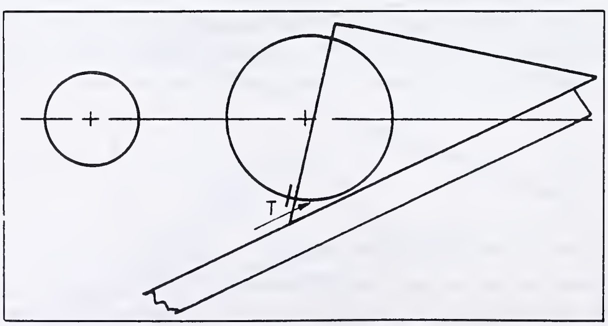
Step 2

Place the T square along the longest edge of the triangle as shown.



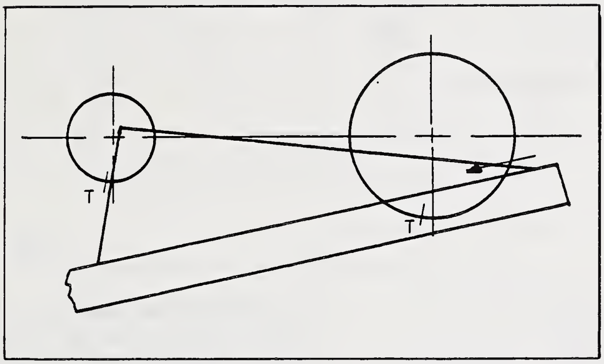
Step 3

Move the triangle along the T square so the centre of one circle is clear. Place the pencil point on the centre of the circle and bring the triangle against the pencil point. Mark the tangent point on the circle as shown below.



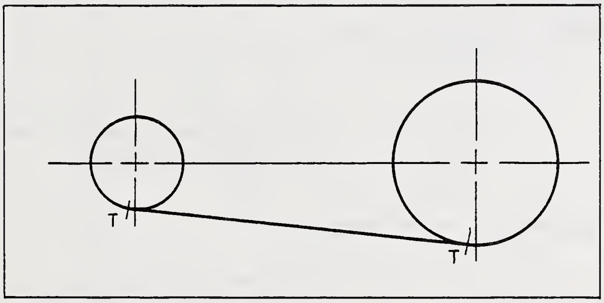
Step 4

Move the triangle to the centre of the other circle and repeat the procedure for marking the tangent point.



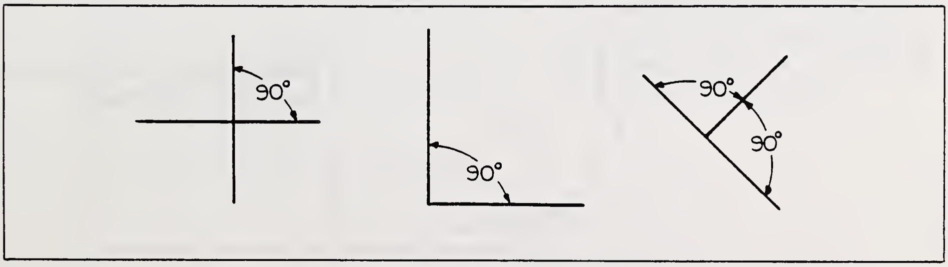
Step 5

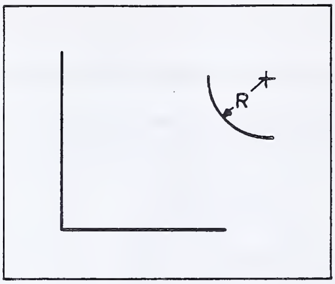
Join the two tangent points by placing the pencil point first on one tangent point, bringing the T square up to it, then on the other tangent point and adjusting the T square against the pencil point.



How to Draw an Arc Tangent to Two Perpendicular Lines

Remember: Perpendicular lines are lines that meet at right angles.

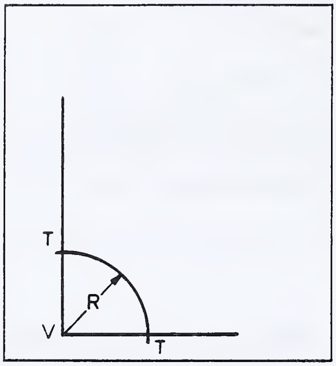




Given: Two perpendicular lines; arc with radius measuring R cm.

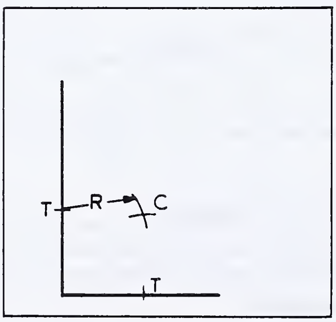
Required: To draw the arc so that it is tangent to both lines.

Step 1



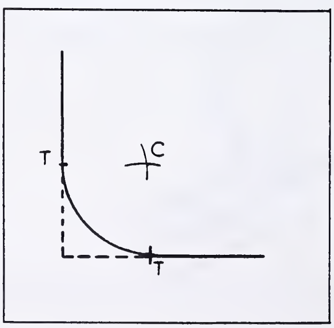
Let the two lines meet at V. Measure off distance VT equal to R on one of the lines. With the compass point at vertex V, set the compass pencil at T and draw the arc of radius R cutting each line at T.

Step 2



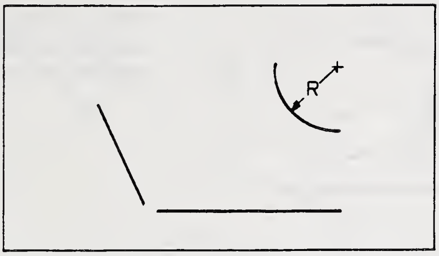
With the same radius R and centres T and T, draw arcs crossing at C.

Step 3



With centre C and radius R draw the required tangent arc from T to T.

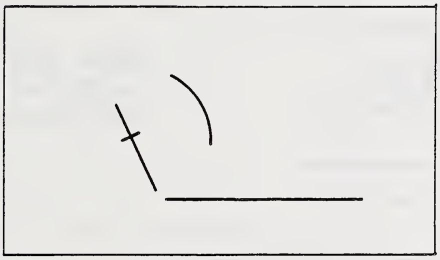
How to Draw an Arc Tangent to Two Lines Not at Right Angles



Given: Two lines not at right angles and an arc of radius R.

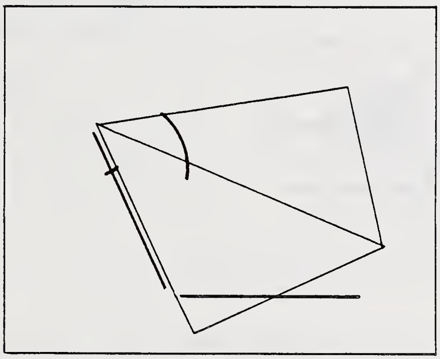
Required: To draw an arc of radius R tangent to both lines.

Step 1



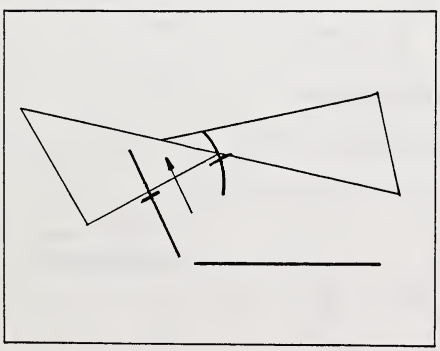
With radius R and compass point anywhere along one of the lines, draw an arc. Mark the position of the compass point.

Step 2



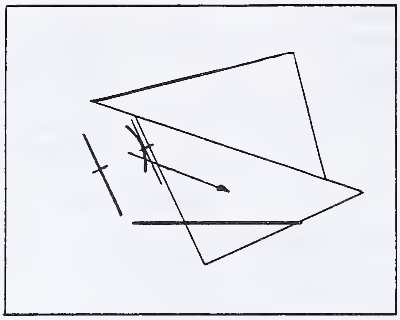
Place the triangles as shown, so that one side of the right angle of one triangle is along the line.

Step 3



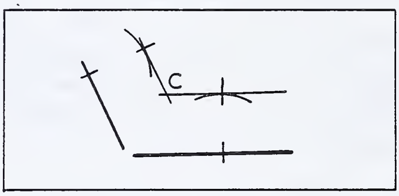
Move this triangle up to clear the position of the compass point. Place the pencil point on the compass point mark and press the triangle against it. Then mark where the perpendicular from the line crosses the arc.

Step 4



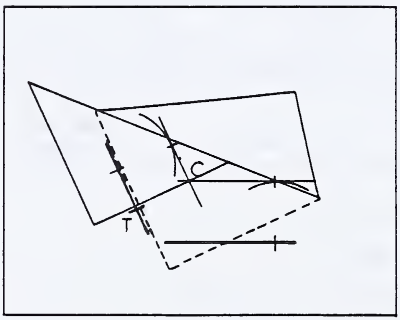
Through this point on the arc draw a line parallel to the given line by the triangles method previously learned.

Step 5



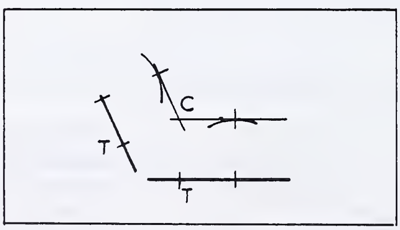
Repeat Steps 1 to 4 with the other line. Let the lines you have drawn parallel to the given line cross at C.

Step 6



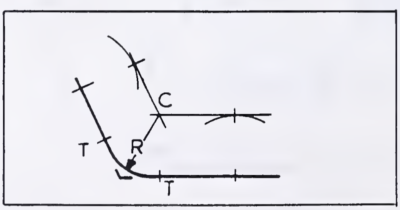
Draw the perpendicular from C to one of the lines, using the two-triangle method.

Step 7



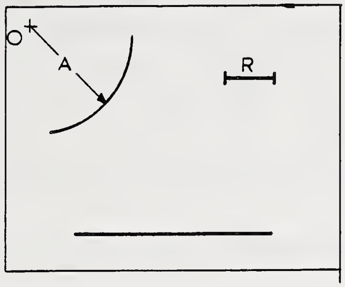
Draw the perpendicular from C to the other line by the same method.

Step 8



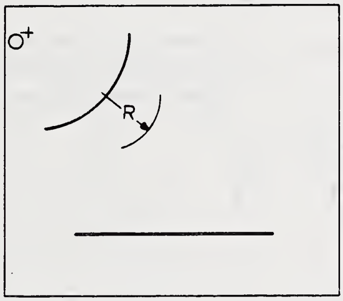
With centre C and radius R draw the required arc.

How to Draw an Arc Tangent to a Given Arc and Line



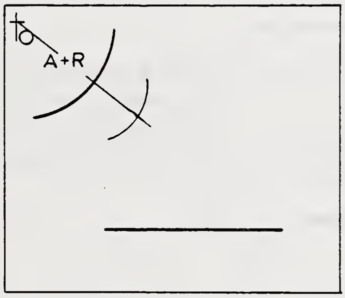
Given: An arc with radius A, a line, and an arc of radius R to be tangent to these two.

Step 1



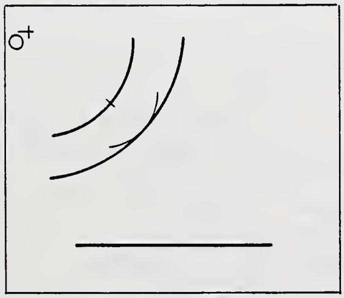
With the centre anywhere on the given arc, draw an arc of radius R. Mark the centre point pierced by the compass needle.

Step 2



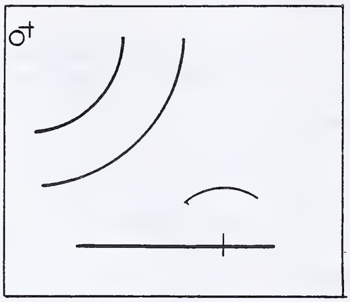
Draw a dash through the arc (with radius A) where a line through the centres of the arcs crosses it.

Step 3



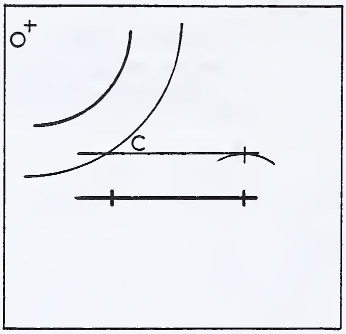
Put the compass point at O and the pencil on the point you have just found, so that your compasses are set to radius A +R, and draw an arc. This arc will be parallel to the given arc.

Step 4



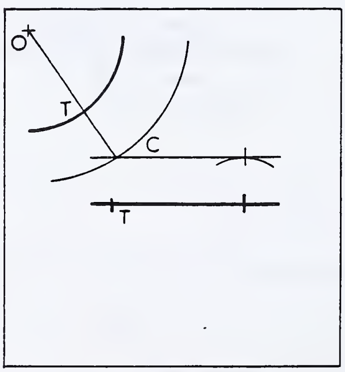
With the centre anywhere on the given line, draw an arc of radius R.

Step 5



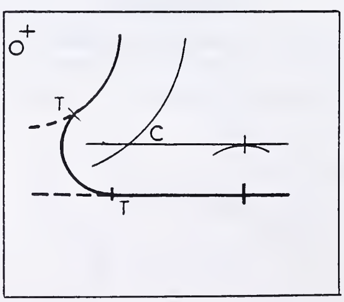
Draw a line tangent to this arc and parallel to the given line by the method of two triangles. Let the line intersect the arc of Step 3 at C.

Step 6



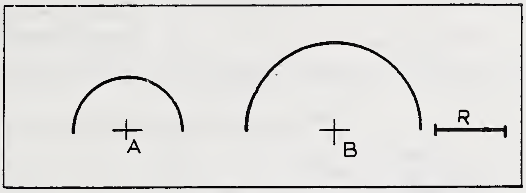
Draw a line from C to O and another line from C perpendicular to the given line by the method of two triangles to draw perpendiculars. Let these lines cut the given arc and given line at T and T.

Step 7



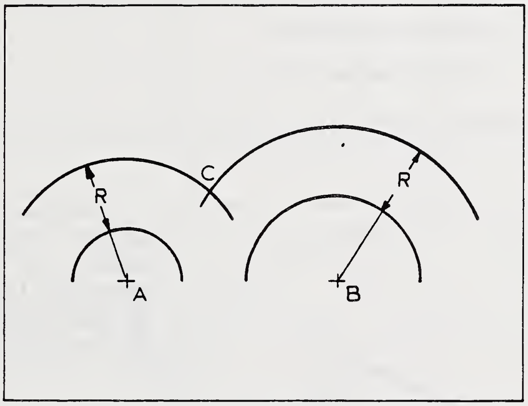
With centre C and radius R, draw the required tangent arc from T to T.

How to Draw an Arc Tangent to Two Arcs



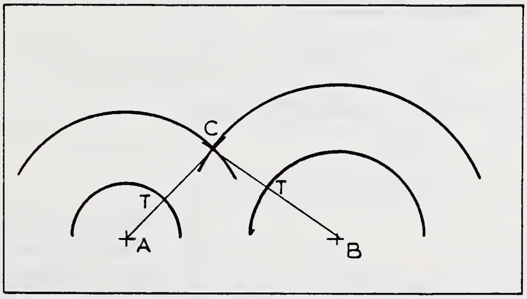
Given: Arcs with centres A and B; and radius of required arc, R.

Step 1



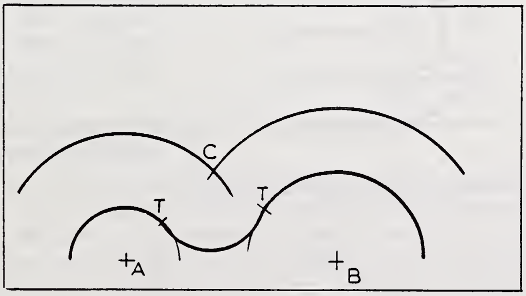
Draw arcs with A and B as centres, parallel to the given arcs and at distance R from them. Add the radius R to that of A or B by the method used on pages 13 and 14. Let the arcs cross at C.

Step 2



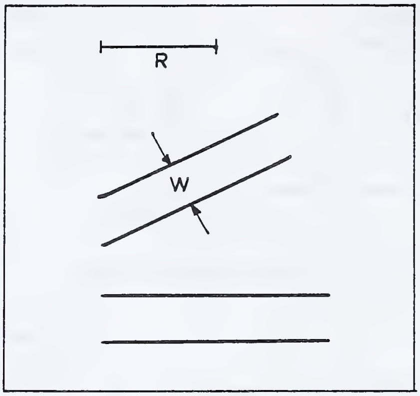
Join CA and CB, crossing the given arcs at T,T.

Step 3



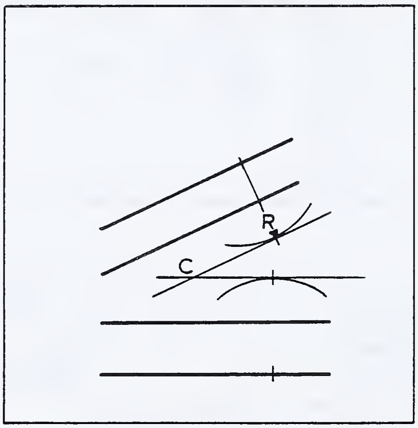
With centre C and radius R draw the required tangent arc from T to T.

How to Draw Parallel Arcs to Join Parallel Pairs of Lines



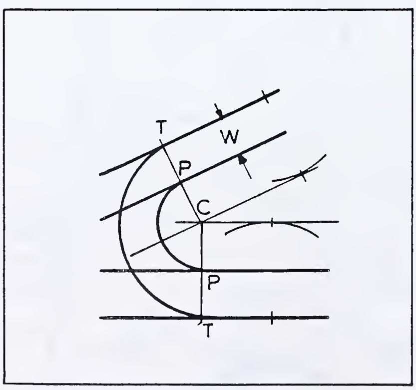
Given: Two pairs of parallel lines W cm apart. Radius of outer arc, R.

Step 1



Draw a line parallel to each given parallel pair at distance R from each outer line. Use the two-triangle method to draw the parallel lines. Let the two lines you draw cross at C.

Step 2



Draw perpendiculars from C to each pair of given parallel lines using the method of two triangles.

Let the perpendiculars cross the given parallel lines at T, T and P, P. With centre C and radius R, draw the tangent arc TT. with centre C and radius CP, draw the tangent arc PP.

The required tangent arcs are parallel and W cm apart.

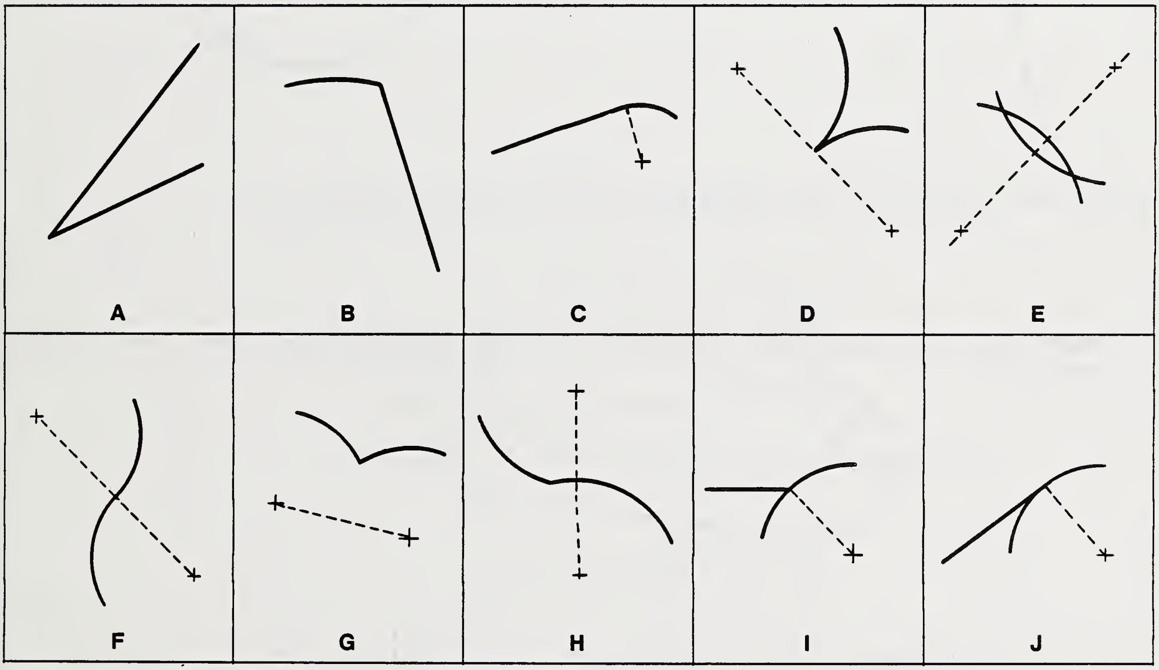
EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Tangents

1. What is the size of the angle between a tangent to a circle and the radius of the circle drawn to the point of tangency? ____________

2. State in which of the drawings below the two lines or curves are tangent to each other.

____

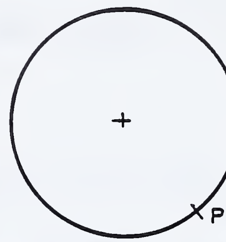


EXERCISE 2: Problems in Drawing Tangent Lines and Arcs

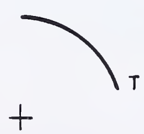
Place the pages on which the problems are printed on your drawing board and draw the constructions required, with instruments, on the printed pages. Do all constructions with a sharp 4H pencil and show all constructions lines and arcs very clearly. Heavy up the completed tangent lines and arcs **ONLY**. Use the H pencil to heavy up the lines, and trace over the arcs several times with the compasses to heavy them up. It will take care and practice to reset your compass radii to their original settings so try to heavy up the final required arcs when you first draw them.

1. Draw a circle with diameter 50 mm on the right side of this line and tangent to it at P.

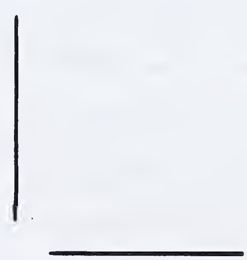
2. Draw a line about 80 mm long tangent to this circle at P.



3. Draw a line 50 mm long which joins this arc smoothly at T.

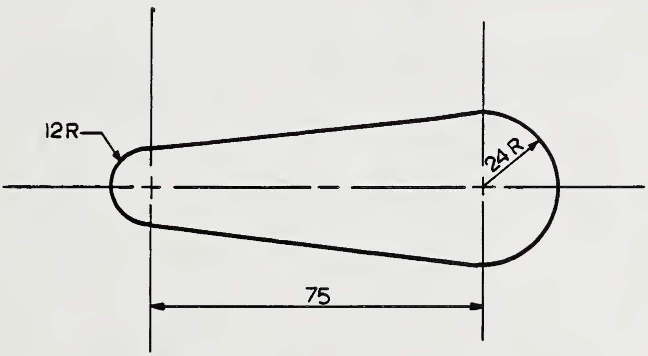


4. Draw an arc of radius 12 mm to meet these lines smoothly.



5. Draw the two lines which are tangent to these circles. Letter each point of tangency, T. Indicate the points by short radial strokes, not dots.

6. Draw the following figure, full scale, with dimensions as shown. All arcs and lines are tangent to each other.



7. In (a) and (b) draw arcs of radius 6 mm to meet these lines and arcs smoothly.

(a)

(b)

8. Draw an arc of radius 12 mm to meet the arcs smoothly.

9. Join the parallel lines by parallel arcs, with the outer arc having a radius of 18 mm.

END OF LESSON 9

LESSON RECORD FORM

1715 DRAFTING 10

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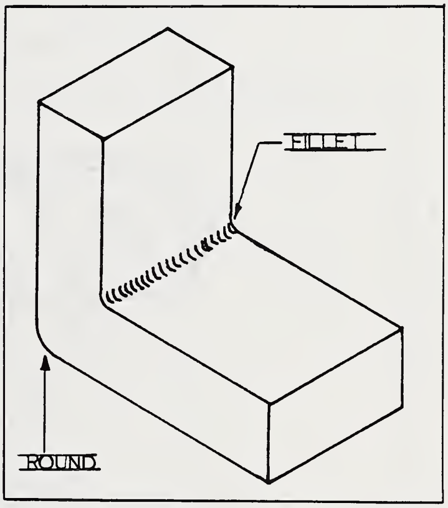
WORKING DRAWINGS OF OBJECTS WITH TANGENT LINES AND ARCS

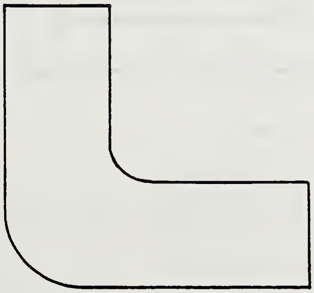
In the objects you are going to draw in this lesson, flat surfaces meet rounded surfaces. You will use the methods learned in Lesson 9 to draw the necessary tangent lines.

Rounds

We mentioned in Lesson 4 that when metal parts are made by casting, sharp corners are avoided. The inside corners are rounded by means of fillets. The mold in which the casting is made is so shaped that the outside corners are also rounded and these corners are called **rounds**.

You would use your knowledge of joining perpendicular lines by tangent arcs to draw the front view of the object shown below.



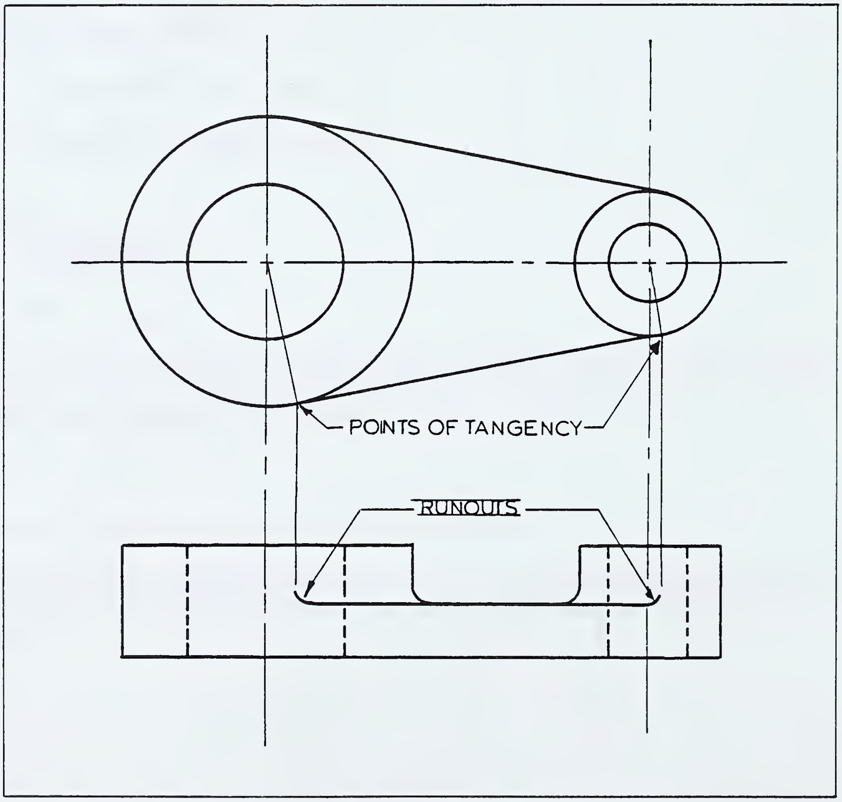


More About Runouts

In Lesson 8 we found that when a flat surface meets a round surface in a fillet, the fillet is shown on the front view by means of a runout.

In Exercise C in this lesson you will have to draw the runouts required in the front view. Below is shown a typical example of how runouts are drawn.

1. Draw the centre lines required in the top view.
2. Note the point of tangency in the top view. This lines up with the END of the runout.
3. The runout is an arc of the same radius as the fillet it represents and of length about 0.12 of the circumference of a circle, from the line to which it is tangent.



Centre Lines

Show horizontal and vertical centre lines through the centre of each hole which appears in the view as a circle. Use these lines to dimension distances between holes. Project the vertical centre lines down through the front view to show the centre axis of each hole. Show the hidden edges of all holes. We have sketched the views for Exercise A as an example of what we mean.

EXERCISES TO BE SENT IN FOR CORRECTION

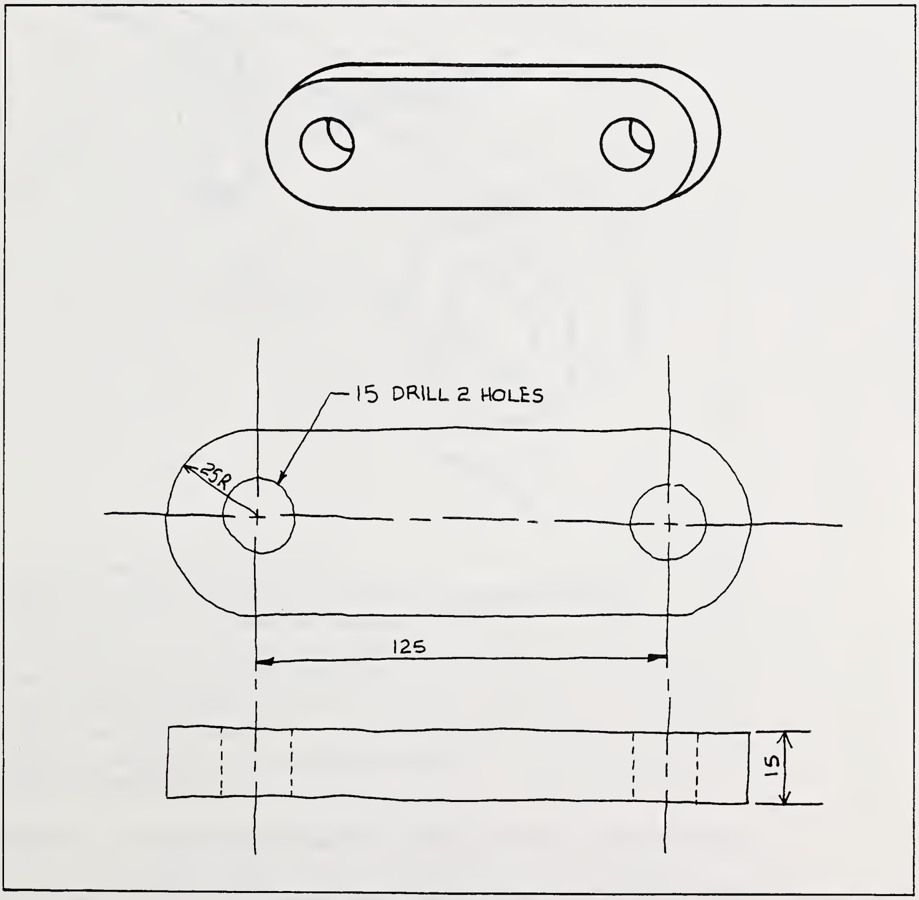
EXERCISE 1: Working Drawings Requiring the Construction of Tangent Lines and Arcs

On four properly prepared plates, lay out each problem centred correctly on a plate. Draw all sizes full scale.

Draw the top and front views only of each object. Choose the top view so that all circular edges are visible on it where possible.

A: Link

Width, 50 mm
Thickness, 15 mm
Centre to centre of drilled holes, 125 mm
Diameter of holes, 15 mm

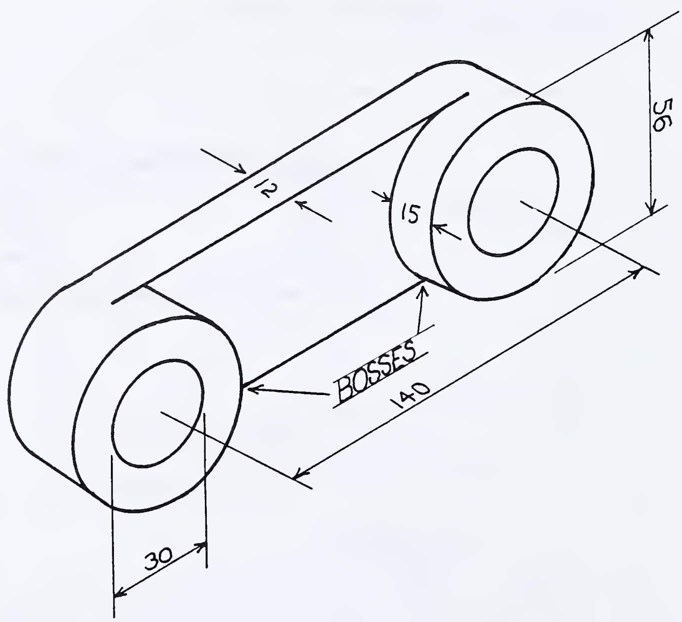


Make the finished working drawing with instruments showing all details as in the sketch. Use the method for centering the drawing as explained in Lesson 5.

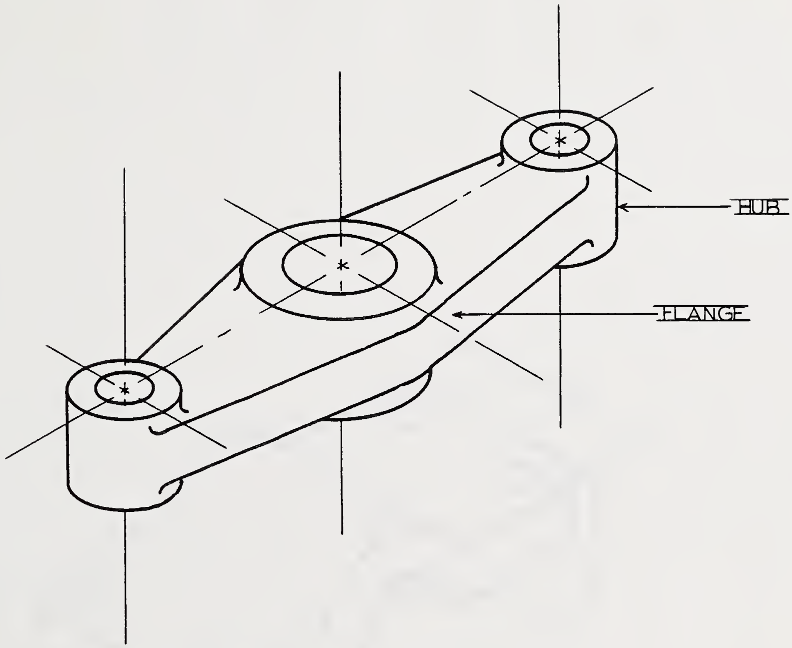
B: Rocker Arm with Bosses

Distance between centres, 140 mm
Thickness of arm, 12 mm
Height of bosses above arm, 15 mm
Diameter of bosses, 56 mm
Diameter of holes, 30 mm

Draw the front view so that the bosses are facing upward and toward the top view. Note that the top of the arm extends to the CENTRE of each boss. Draw a rough sketch on scrap paper before attempting the drawing on your plate. Attach this sketch to your drawing. Use the sketch to decide the best places for locating all necessary dimensions on the finished drawing. See the checklist in Lesson 5 for further clarification.



C: Rocker Arm with Hubs

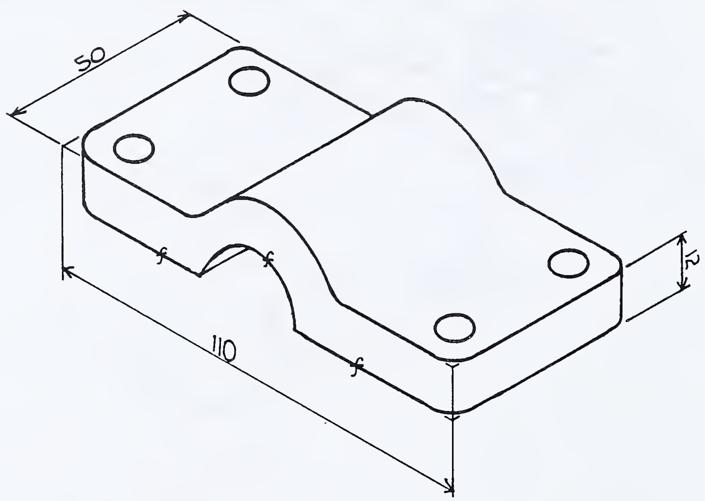


Outside diameter of ends, 30 mm
Distance, centres of end holes to centre of centre hole, 76 mm
Total centre-to-centre distance, 152 mm
Outside diameter of centre hub, 54 mm
Inside diameter of centre hub, 30 mm
Inside diameters of ends, 15 mm
Thickness of hubs, 30 mm
Thickness of flange, 18 mm centred along hubs
Radius of all fillets, 3 mm

NOTE: Arc at centre of flange has a radius of 30 mm, to allow for fillet.

You may OMIT showing any dimensions on your finished drawing but measure all sizes to scale. First draw a sketch of the two views properly lined up. Show all centre lines. Show all fillets and runouts. End the runouts at correct points as explained in this lesson. Use the correct method of drawing all tangent lines, as instructed in Lesson 9. (For practice show each point of tangency with a light construction dash.)

D: Frame Guide



Length, 110 mm
Width, 50 mm
Thickness, 12 mm
Outer radius of centre portion, 30 mm
Inner radius of centre portion, 18 mm
Distance between centres of drilled holes, 26 mm
Distance of holes from centre of object, 43 mm
Diameter of holes, 9 mm (Drill 4 holes)
Radius of rounds, 12 mm
Radius of fillets, 3 mm

First draw a sketch of the two views properly lined up and dimensioned. Show all necessary dimensions on the final drawing. Use the correct method of drawing tangent arcs to draw the rounds and fillets as well as the curved edges. Indicate each edge of a surface to be finished with the proper "finish" symbol.

END OF LESSON 10

LESSON RECORD FORM

1715 DRAFTING 10

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SECTIONAL VIEWS

Sectional Views

The views used in Orthographic Projection enable us to see clearly the outside features of any object. Hidden edge lines assist us by showing edges which are behind the face of the object being viewed.

However, if the object has construction features inside it which are not visible from the outside, hidden lines are not adequate for showing these details. Instead, the interior of the object can be exposed by making an imaginary slice through it, cutting it in such a way as to make visible all the detail required. For instance, if an apple is sliced in half along the axis of the stalk, all the details of the core become visible.

In a similar manner, the inside details of a mechanical object would become visible if it were cut open. One of the faces exposed by this slicing could then be drawn and it would show all of these interior details. Such a drawing is called a **sectional view**.

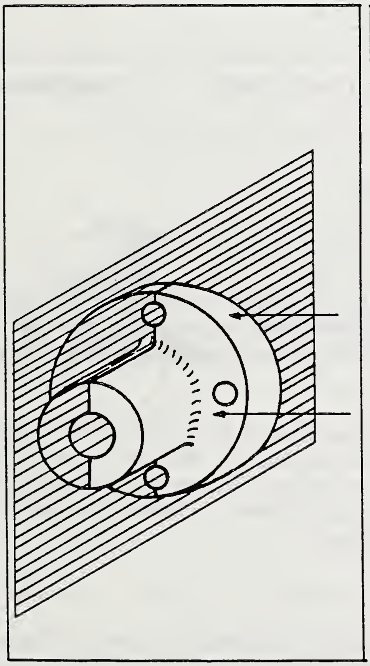


Fig. 11-1

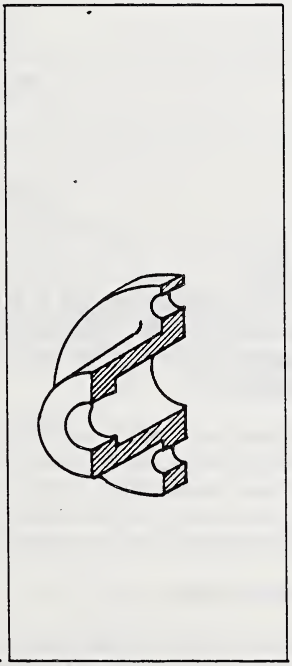


Fig. 11-2

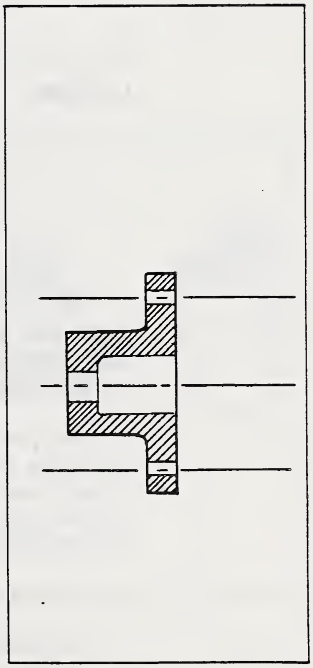
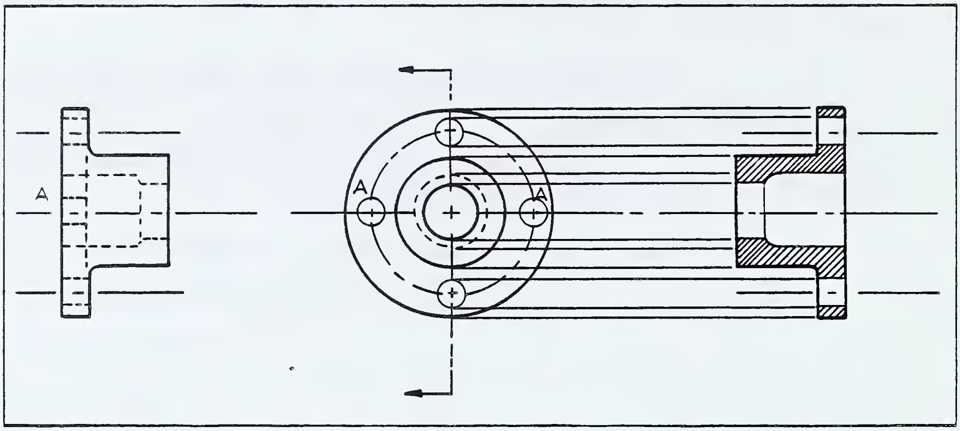


Fig. 11-3

In Fig. 11-1 we show a coupling. The solid outline shows how it appears to the eye. The shaded rectangle indicates the plane along which it is necessary to slice the coupling in order to get the desired sectional view. the arrows indicate the direction of sight toward which we shall look at the object after it has been sliced through and the right half removed.

In Fig. 11-2 the right half has been removed revealing the interior of the coupling. The shaded regions show the surface of the metal AT THE CUT. The lines used for the shading are called **crosshatching**.

Notice that the end edges of all the holes cut through are visible and appear as half ellipses. On orthographic projections, we know that faces are viewed from directly in front of the observer. When in this position the section appears as in Fig. 11-3. This view is the Right Side sectional view because it is viewed from the right. Note especially that because this view is directly in front of the observer the rounded edges of the holes appear as STRAIGHT object lines.



Left Side **Fig. 11-4 Front** **Right Side in Full Section**

Fig. 11-4 is a working drawing of the same object in Orthographic Projection, with the Right Side shown in section. The construction lines are shown so that you can see how the views are projected from the front view. These lines must be very light, much lighter than we can make them in print.

For practical purposes the left side would not be drawn but we have included it so as to show how much clearer the sectional view is than the standard exterior view. Notice that even in sectional views some edges are hidden. Hidden edge lines are **NOT** drawn in sectional views as a general rule. Thus hole A is shown by hidden lines in the Left Side view, but it is **NOT** shown at all in the sectional view.

1. Cutting-Plane Lines

Review how to draw cutting-plane lines as mentioned in Lesson 1. The cutting-plane line shown in the Front View in Fig. 11-4 indicates that we are viewing the section from the right side, looking toward the left. Hence the arrows point left and the section view appears as the Right Side view. In most drawings where there is but one cutting plane and it is on an axis of symmetry, the cutting-plane line is omitted even though a sectional view is included.

2. Crosshatching

The crosshatching is done with a 45° triangle. Use a 4H pencil as these are light lines. The lines must be evenly spaced and this should be done by eye since there are far too many lines to make it practical to measure the spacing. The spacing distance may be different for different drawings, depending on the size of the drawing. Space the lines from 2 mm to 3 mm apart. For any one single object slope all the lines in the same direction. A region crosshatched in a different directions indicates a separate object interlocking with the original object.

It is quite easy to draw the crosshatching if you use the method you have learned for drawing parallel lines. Just lay a 45° triangle along the T square so that the T square is well removed from the region to be crosshatched. Wherever the long edge of the triangle passes through a region of the metal or other material that is cut, draw a line across it, starting at the left of the drawing. Then slide the triangle along the T square, drawing each crosshatch line in turn and keeping all of them, as nearly as you can, equally spaced.

Full Sections and Half Sections

When the cutting plane slices completely through the object we obtain a **full section**.

If the slice is taken only half-way through and then met by a perpendicular slice so that a quarter of the object is observed, we obtain when we view the object along the line of sight, a **half section**.

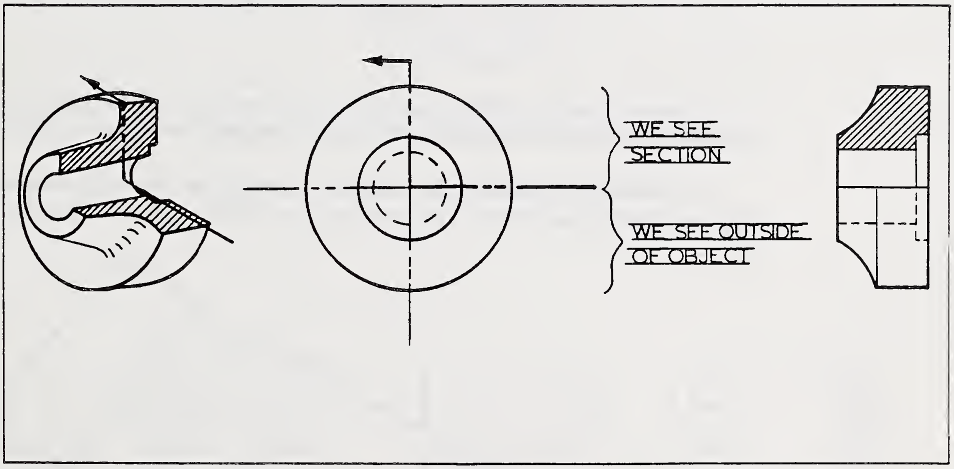


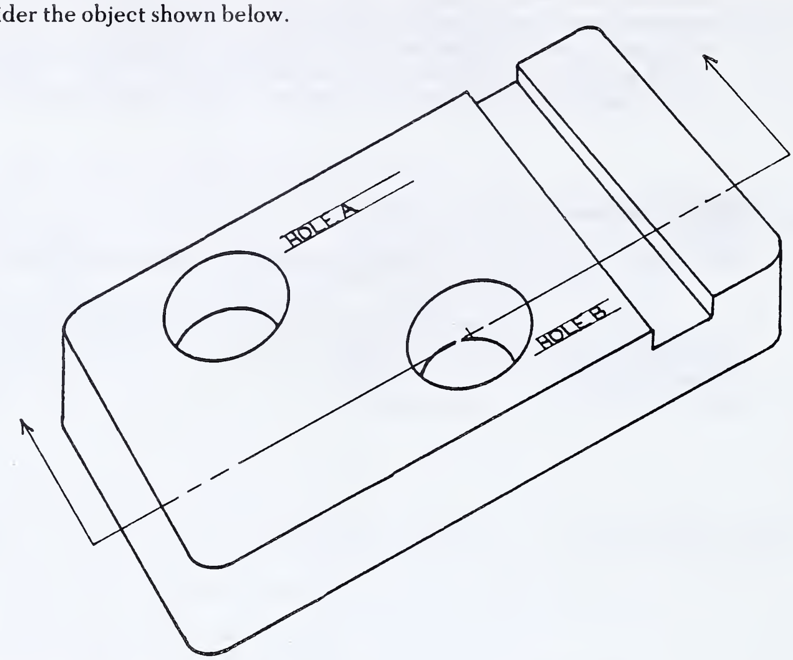
Fig. 11-5: The Right Side view is a half section.

When we look at the above object from the RIGHT, the upper half appears in section, but in the lower half we see the outside only. Consequently, the Right Side view shows the upper half in section, and the lower half in standard orthographic projection with hidden lines. There is a line where the halves meet. This line is formed by the intersection of the two perpendicular cutting planes.

It may be drawn either as a visible object line or as a centre line.

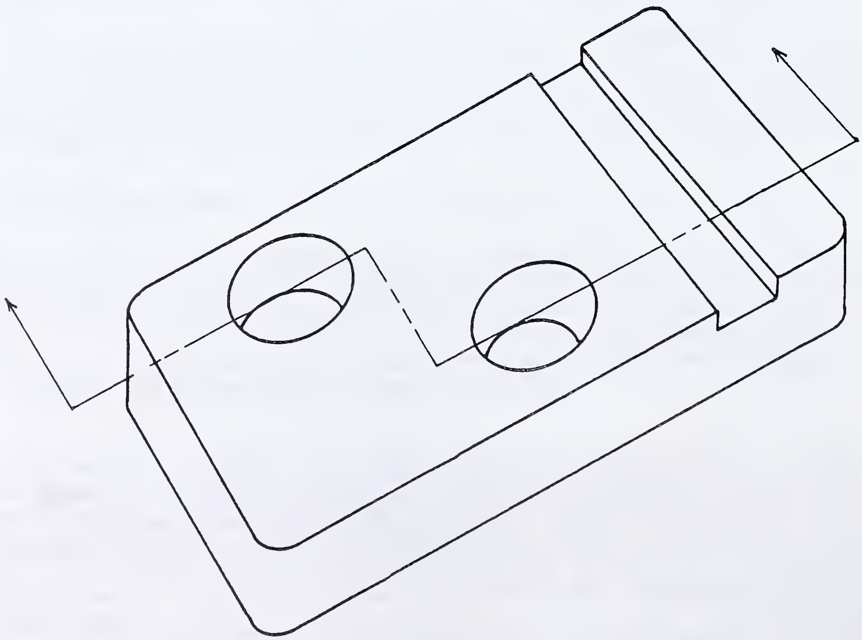
Bending the Cutting Plane

You can also bend the cutting plane to get a clearer view of all the parts of the object. Consider the object shown below.



If only a straight cutting plane were to be used (as shown above), then hole A would be completely missed and would not show on the sectional view. How could the hole be shown?

The solution is quite simple. Bend the cutting plane line so it goes through both holes, as shown in the diagram below. The sectional view will then show both holes.



EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Sectional Views

1. The place where the sectional view is taken is indicated by a line consisting of heavy alternating long and two short dashes. This line is called a (Underline the correct words.)

   (a) detail line.

   (b) section line.

   (c) construction line.

   (d) cutting-plane line.

   (e) view line.

2. If an assembly is made up of interlocking parts the crosshatching should be in the same direction for all parts. True or False?

   ____

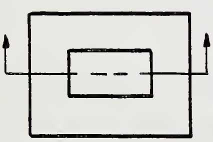
3. Complete the table of pairs of views which go together.

   C — 1

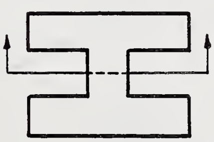
   A —

   B —

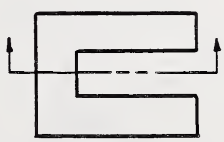
   D —



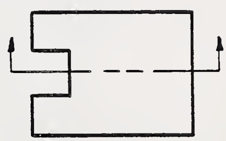
A



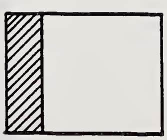
B



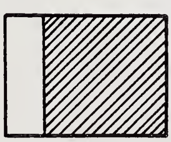
C



D



1



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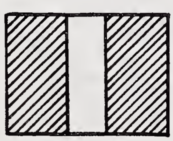

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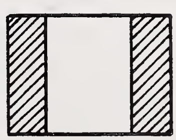

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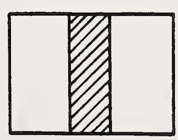


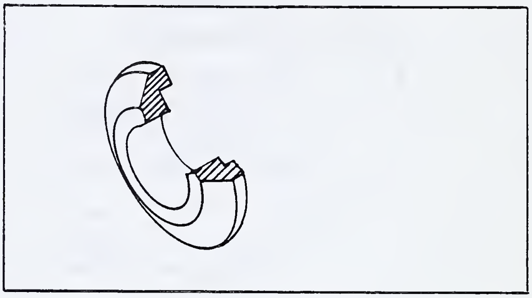
5

EXERCISE 2: Working Drawings Requiring Sectional Views

Make finished working drawings of the following articles. Use a prepared plate for each drawing. Draw two views of each object, and be sure that one of the two views is a full section. (You may try the Half Section View if you wish. If you do, the remaining portion must be in the correct orthographic form.) Make sure that the two views which you draw, however, completely describe the object. Make a rough sketch before starting any problem on the drawing board. Include all necessary dimensions in all drawings.

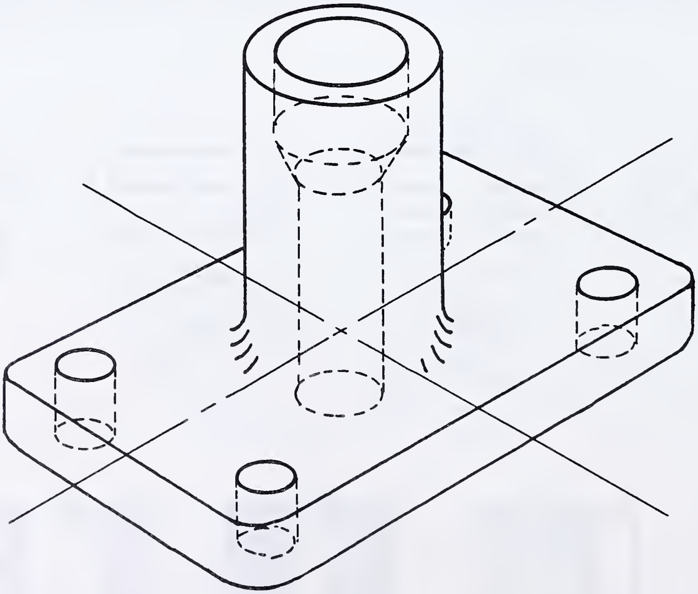
A: Arbor Washer

Outside diameter, 76 mm
Height, 14 mm
Small diameter, 42 mm
Diameter of hole, 22 mm
Counter bore 3 mm × 50 mm
Thickness of outer edge, 4 mm



B. Bronze Housing

Dimensions of base, 12 mm × 60mm × 100 mm (before rounding)
Radii of rounds, 12 mm
Outside of cylinder, 38 mm, inside 26 mm, 14 mm deep, then tapering to 16 mm at 45°
Height of cylinder above base, 60 mm
Radius of fillet, 6 mm
Diameter of holes in base, 12 mm: drill 4 holes, centres 38 mm from centre line of width and 18 mm from centre line of length of base.



END OF LESSON 11

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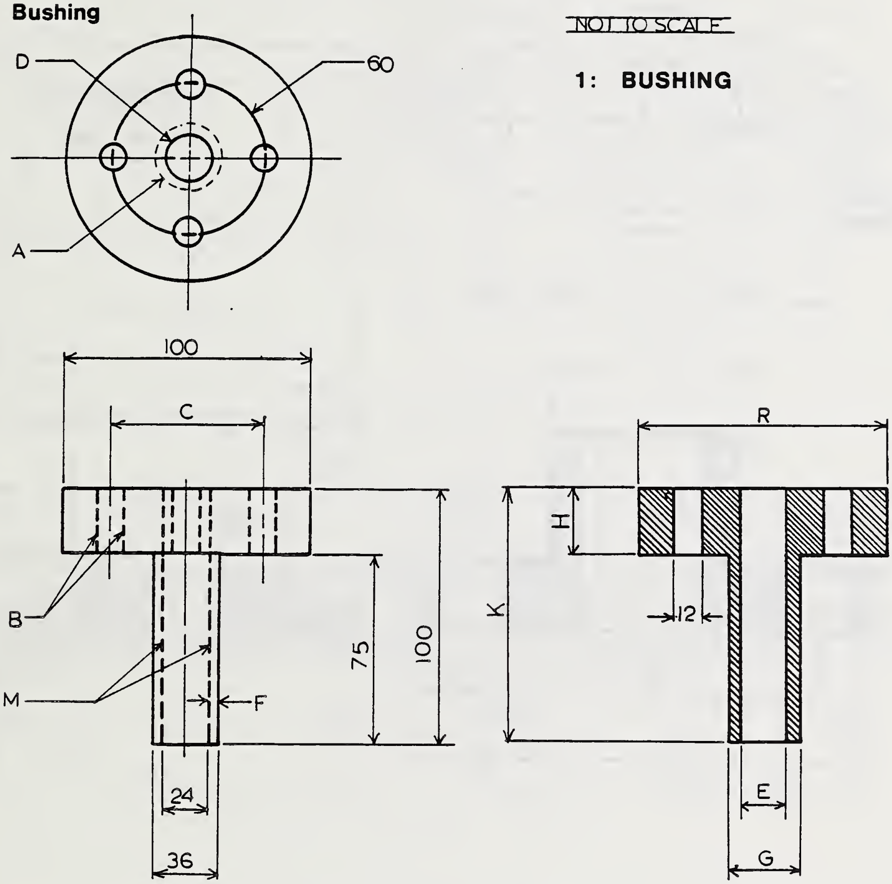
REVIEW LESSON

This is a review lesson consisting of exercises only. Please send in **all** exercises for correction.

EXERCISE 1: Bushing



1. C = G = K = F =

   E = D = H = R =

2. The crosshatching in the right side view indicates that the view is

   ____

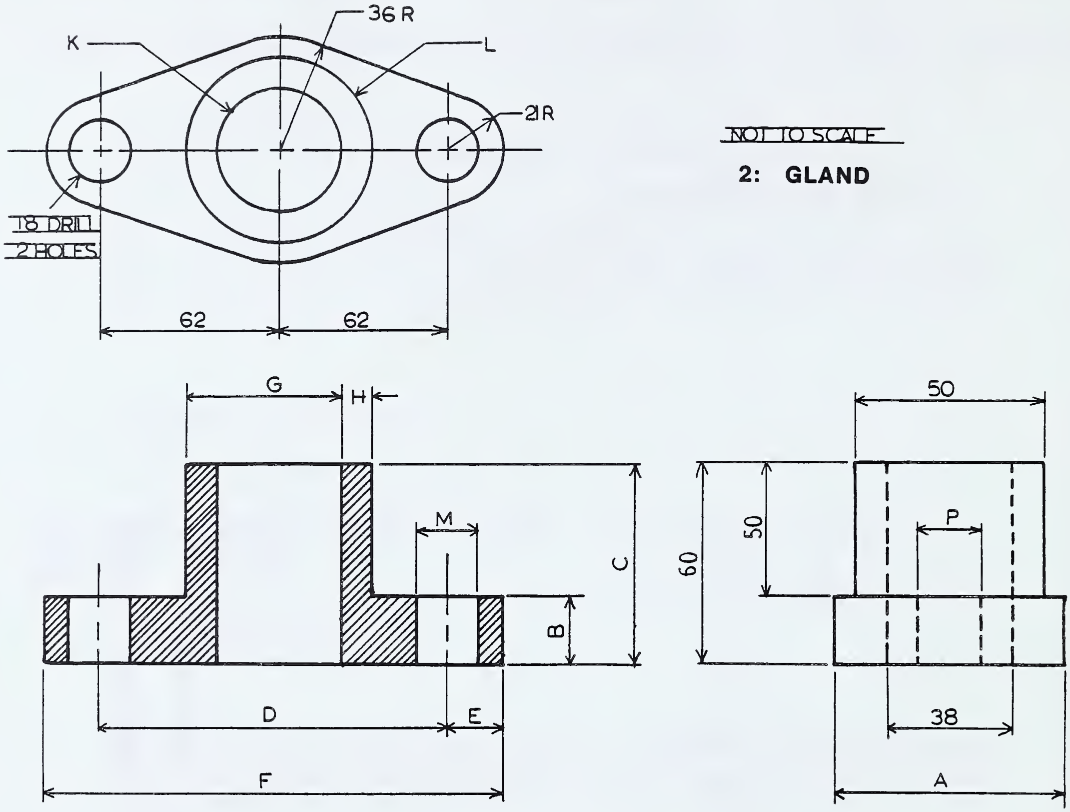
3. Circle A is dashed because ______________________________

   ____

4. The diameter of circle A is ______________________________

5. Lines B represent ______________________________

6. Lines M represent ______________________________



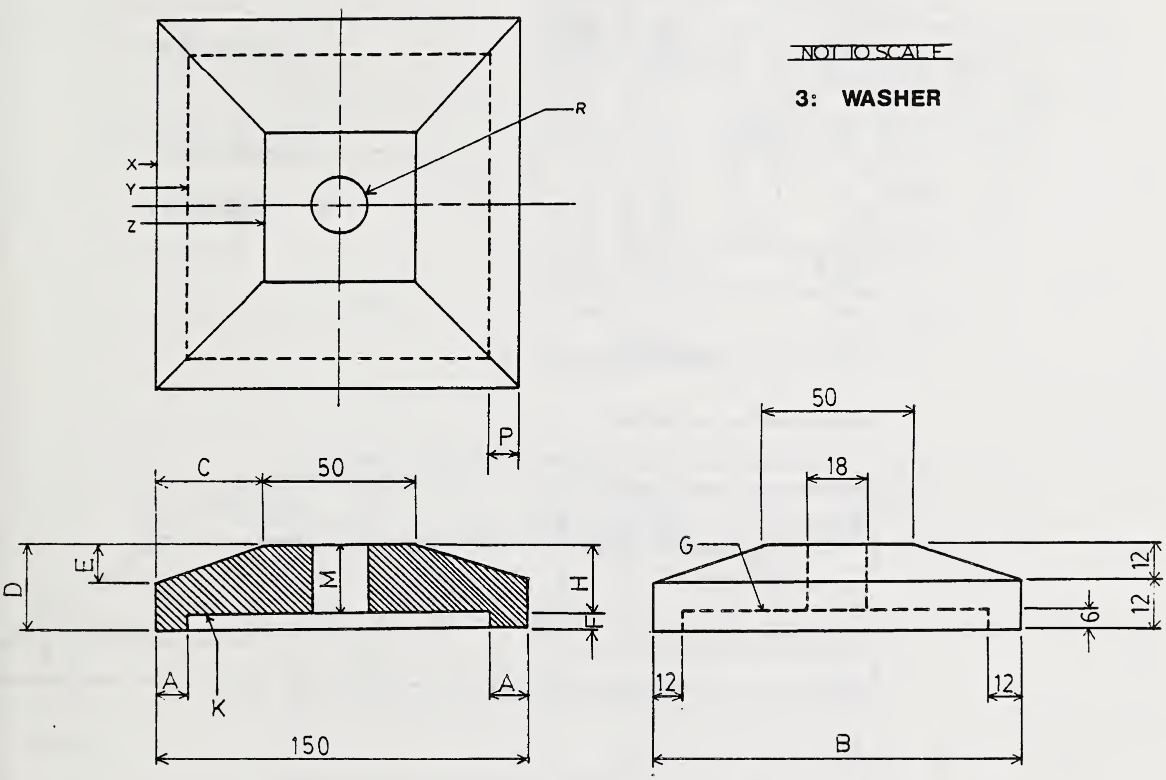
NOT TO SCALE

2: GLAND

EXERCISE 2: Gland

A =	G =
B =	H =
C =	K =
D =	L =
E =	M =
F =	P =

EXERCISE 3: Washer



A =

B =

C =

D =

E =

F =

H =

M =

X =
(Give the length of one side.)

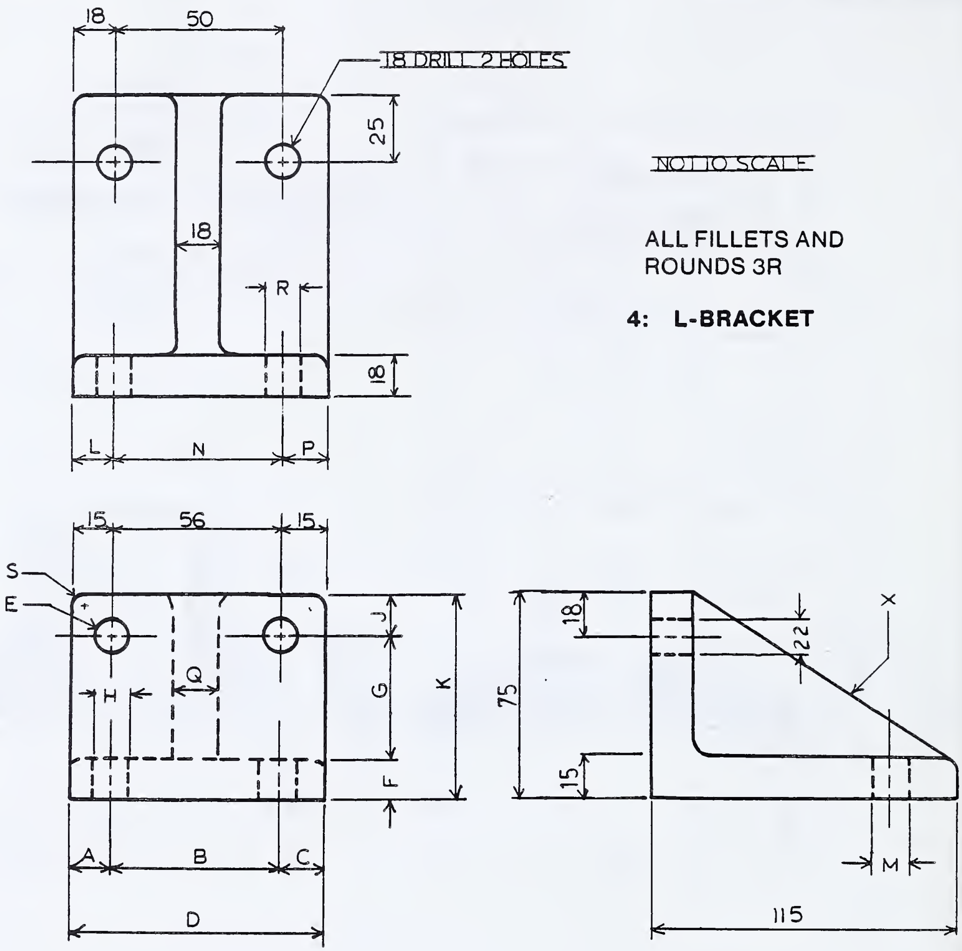
Y =

Z =

R =

P =

EXERCISE 4: L-Bracket



1. The dashed lines at H represent ______________________

2. What is X? ______________________

   The thickness of X is ______________________

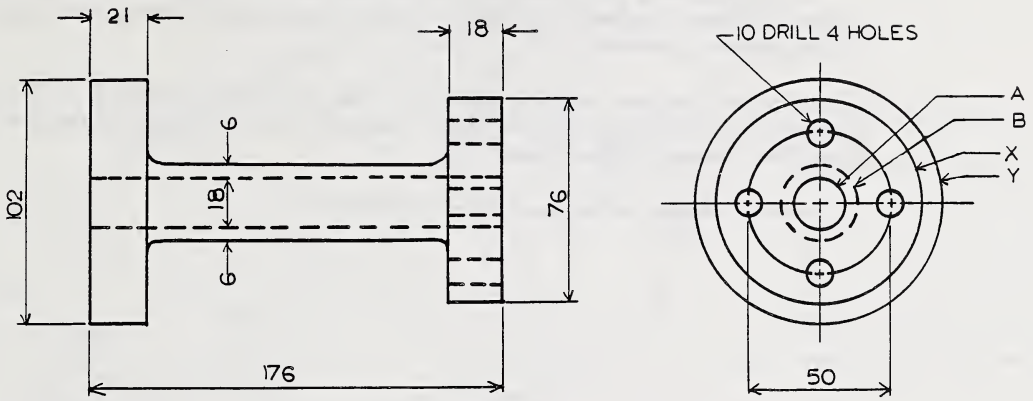
3. A = E = J = N =

   B = F = K = P =

   C = G = L = R =

   D = H = M = S =

EXERCISE 5: Flanged Pipe



5: FLANGED PIPE

1. The inside diameter of the pipe is ________________ .

2. The outside diameter of the pipe is ________________ .

3. The diameter of the large flange is ________________ .

4. The diameter of the small flange is ________________ .

5. The thickness of the large flange is ________________ .

6. The thickness of the small flange is ________________ .

7. The thickness of the metal in the pipe is ________________ .

8. The length of the pipe is ________________ .

9. The distance between the flanges is ________________ .

10. The diameter of the bolt circle is ________________ .

11. The diameter of the bolt holes is ________________ .

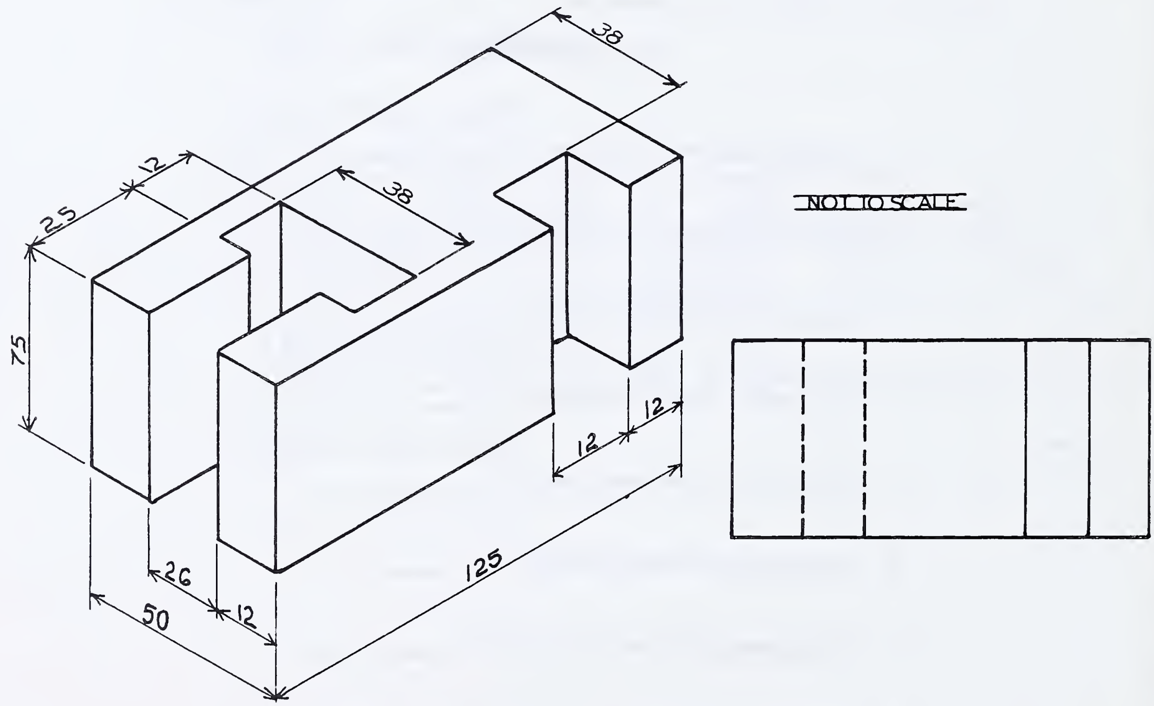
12. The bolt holes are in the (large, small) flange. (Circle the correct word.)

EXERCISE 6: More Practise in Orthographic Sketching

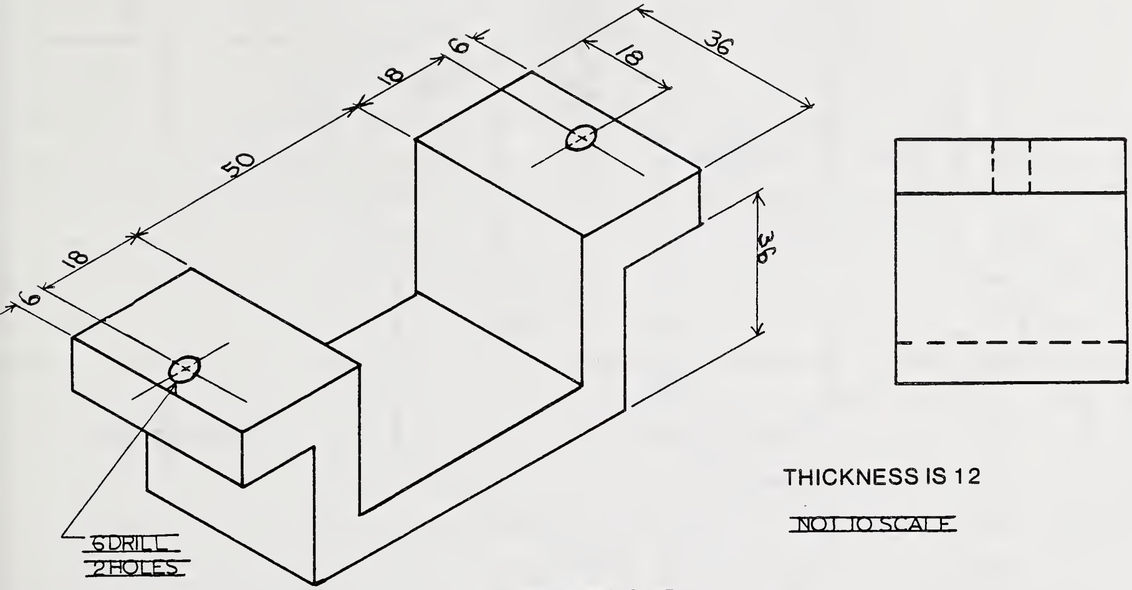
Do the following four sketches in accordance with the six points listed on page 7 of Lesson 8. (It may be a good idea to review any errors in Lesson 8 at this time. Lesson 4, page 7, also gives the instructions.)

Note that the front view you are given is not always shown in front on the pictorial drawing. You will have to turn the object around in your mind to get the required view in front. This is especially true in object D.

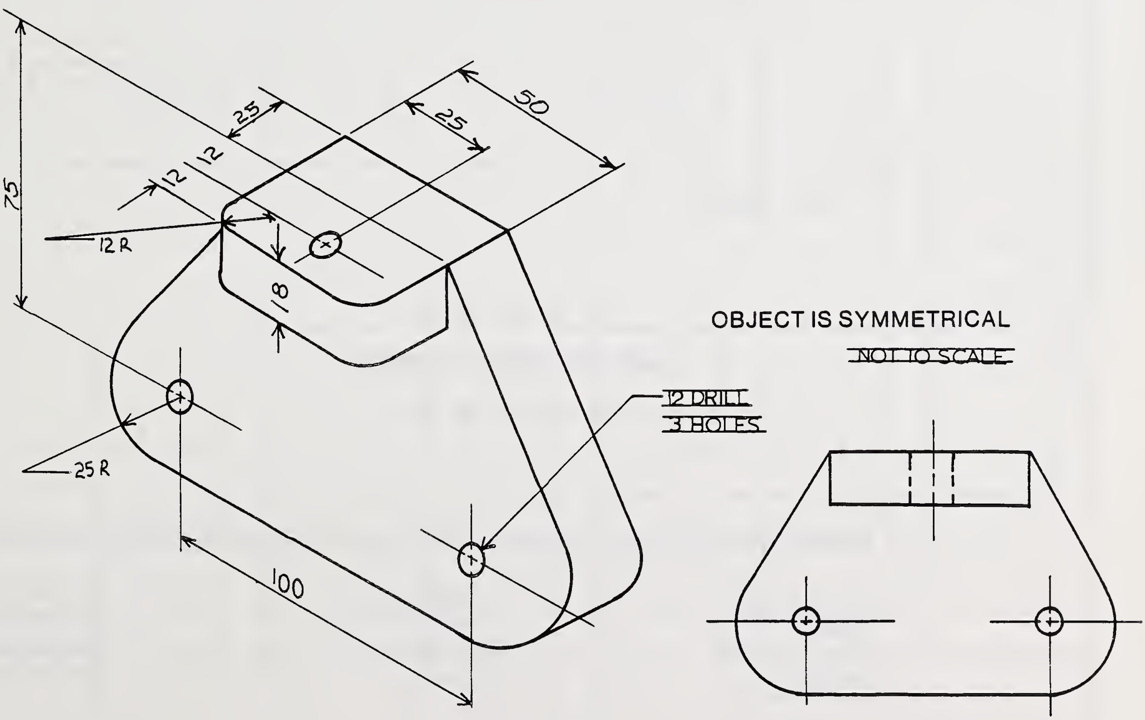
Be sure to include all dimensions on your sketches.



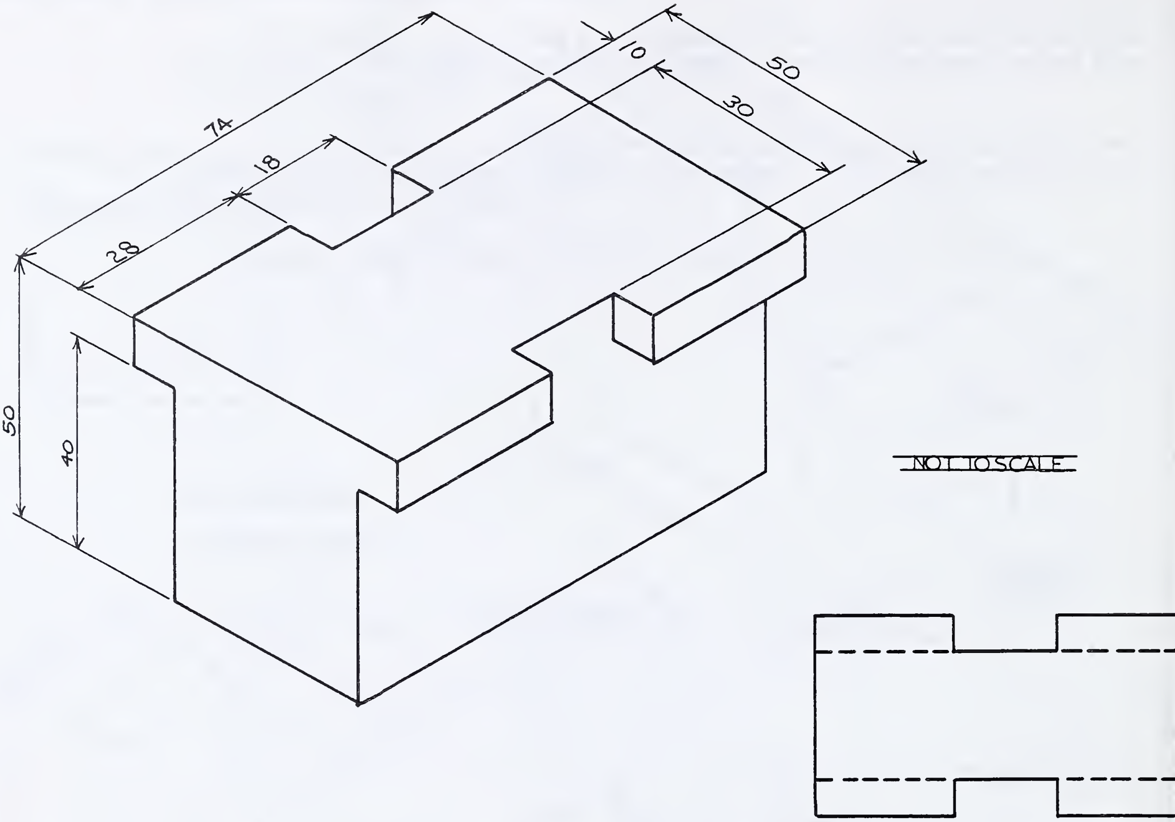
A: T-SLOTTED BLOCK



B: STAKE YOKE



C: TOOL GUIDE



D: ANVIL

★ ★ ★ ★ ★

END OF 3-CREDIT COURSE

★ ★ ★ ★ ★

ATTENTION! When you sit for the final test be sure to have access to the following items.

Drawing board	sandpaper	30° - 60° triangle
T square	eraser	45° triangle
Compasses and dividers	duster	drafting tape
	scale	4H and H pencils

END OF LESSON 12

DRAFTING 10

Lessons 13 through 16

(for students in the 4-credit course)

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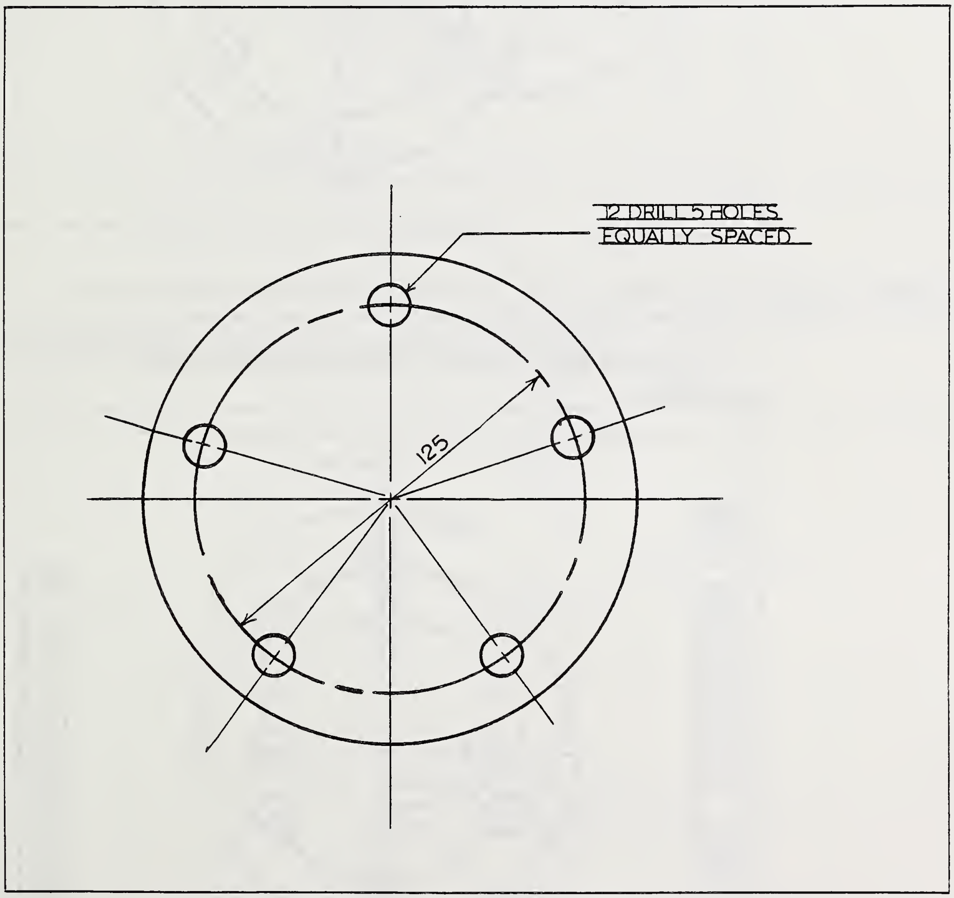
ALIGNED SECTIONAL VIEWS

This and the following lessons are only for students registered in the FOUR and FIVE-credit courses.

Circle of Centres

When a series of holes are to be drilled around the rim of a circular object at a constant distance from its centre, the centre line through the centres of all the holes becomes a circle. This circle is called the circle of centres or bolt circle and should always be shown in the same style as any centre line. Dimension the location of the holes by giving the DIAMETER of the bolt circle, as shown in the diagram below.

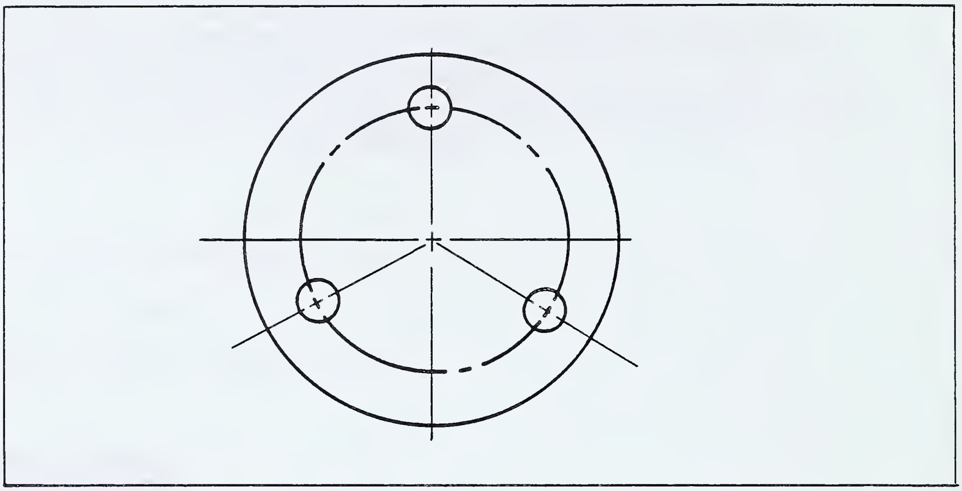


Be sure to include the bolt circle and its diameter in the front view of all such objects. Dimensioning from centre to centre on the side view is not satisfactory.

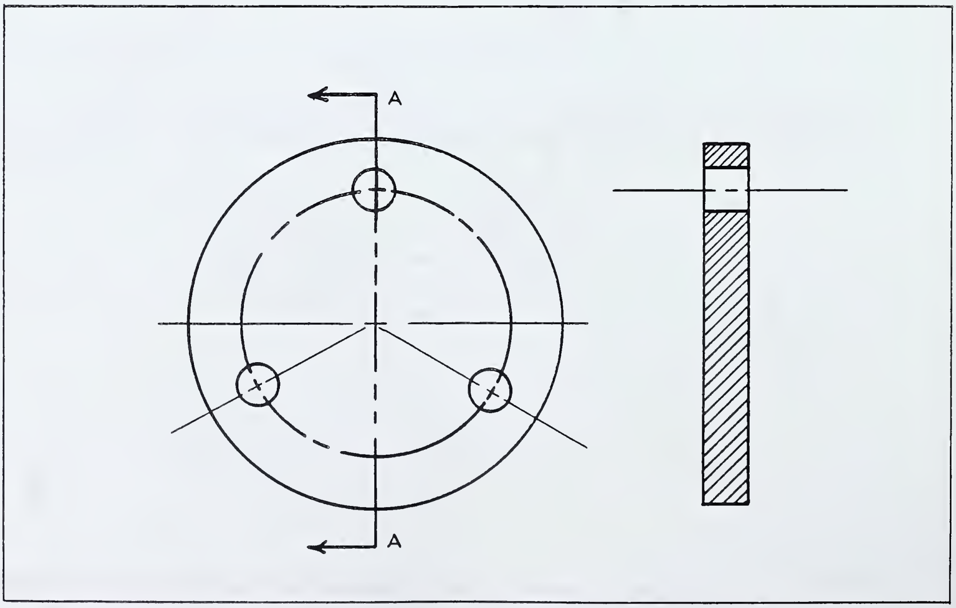
Aligned Sectional Views

When objects are basically symmetrical in nature, they are shown in section in such a way that this symmetry is maintained. An example will show what we mean.

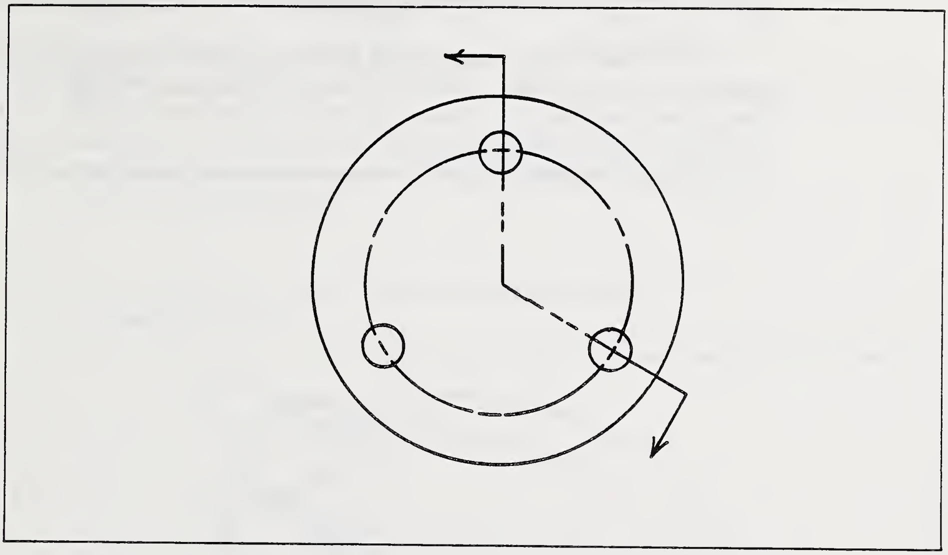
The disk shown below in front view is symmetrical about its centre, since all three holes have their centres on the bolt circle.



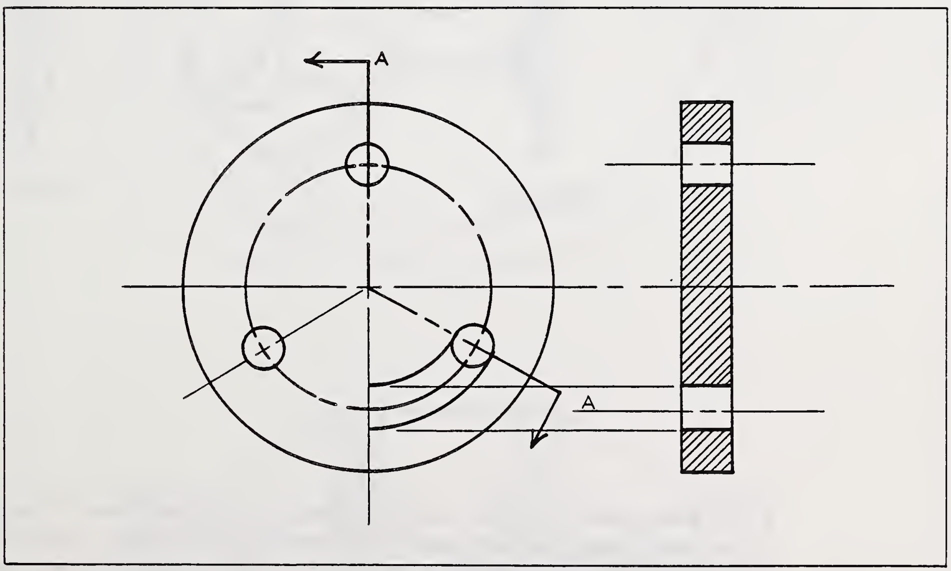
Suppose we drew a sectional view choosing cutting plane A. Then our result would be as shown below.



We have made no error, yet the sectional view gives an impression of imbalance since the upper half differs from the lower half. To avoid this we first bend the cutting plane as shown below.



We then revolve through 60° the lower half of this cutting plane which is not along the vertical axis, so bringing it into line vertically with the upper half. Then with the two halves of the cutting plane aligned the sectional view is projected.

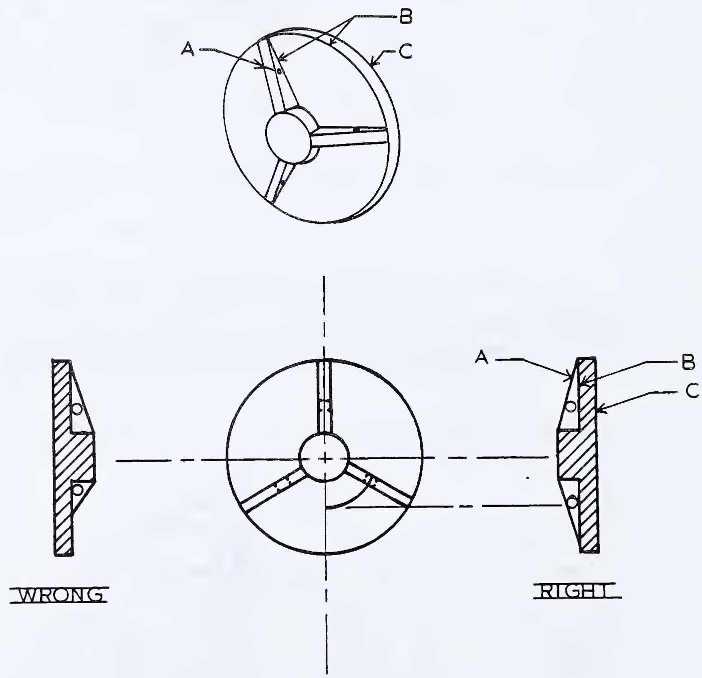


The sectional view now shows the basic symmetry of the object. The spacing of the holes with respect to the rim is clear, and the front view indicates where the holes are located.

Ribs in Section

An object which is basically a flat disk is often strengthened by means of ribs which extend between the centre hub and the rim. In a sectional view the ribs are shown TRUE LENGTH by revolving and aligning the cutting plane vertically as previously explained.

However, it is standard practice NOT to section the ribs. The portion of the object shown in section indicates the general shape of the cross section of most of the object, not that of the thin piece which makes up the rib. In the drawing below, A is the outer edge of a rib, B is the edge of the surface flush with the inside of the rib, and C is the back edge of the disk. Notice how edges A, B, and C correspond in the pictorial view and the sectional view.



This standard practice results in a drawing which is not exactly what we should see if the real object was actually cut open. But by making the drawing in this way, the view is clearer to the eye. To understand the drawing, the draftsman and workman must be familiar with this practice. A practice which is an exception like this to the general rule is called a **convention.**

EXERCISES TO BE SENT IN FOR CORRECTION

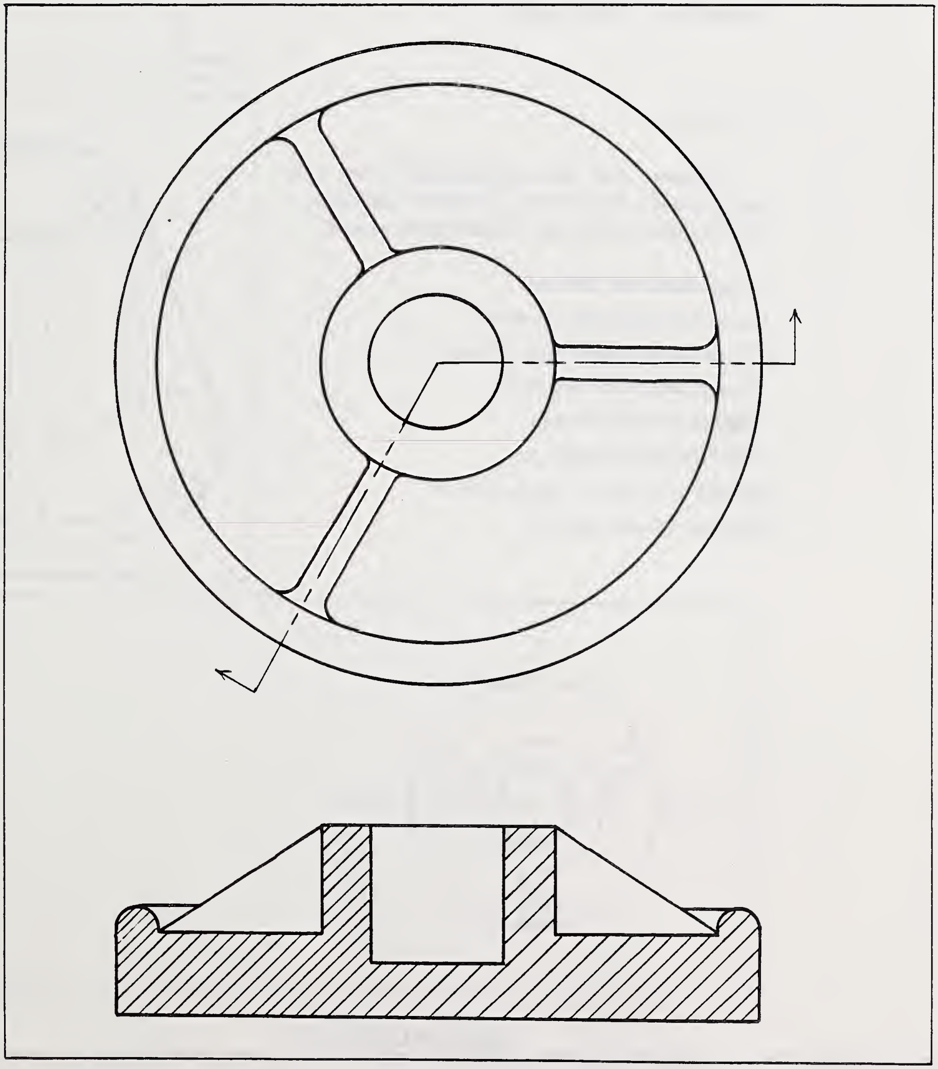
EXERCISE 1: Sectional Views

State whether the following statements are True or False.

1. In sectional views part of the cutting plane may be rotated to provide a balanced view. ____________

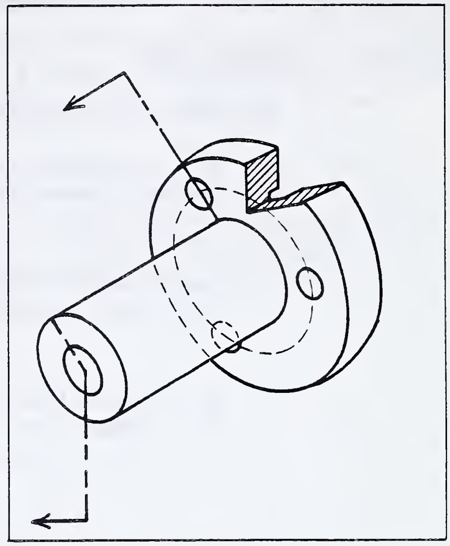
2. Ribs are not shown in section even though the cutting plane, in theory, passes through them. ____________

3. In the sectional view of the drawing below, the oblique lines are the edges of the ribs. ____________



EXERCISE 2: Working Drawings Requiring Aligned Sectional Views

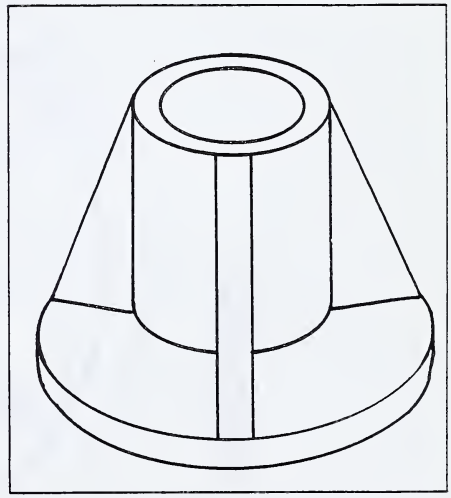
A: Cylinder Head



Draw on a properly prepared plate the Front View, and a full sectional Right Side View of the cylinder head.

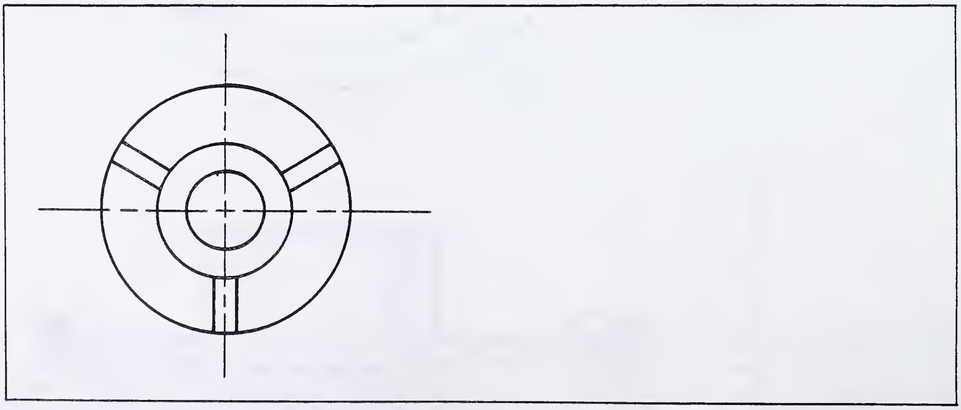
Total length, 65 mm
Diameter of flange, 68 mm
Thickness of flange, 9 mm
Counterbore, 3 mm × 44 mm
Diameter of cylindrical projection, 30 mm
Diameter of shaft hole, 16 mm: Hole extends through entire length of object.
Diameter of bolt circle, 56 mm
Diameter of 3 holes, 6 mm

B: Hub



Assume that the orthographic view you are given is a front view. Recopy it and draw a full sectional right view of the object as well.

Large diameter, 100 mm
Outer hub diameter, 50 mm
Diameter of centre hole, 26 mm
Centre hole is 45 mm deep
Thickness of ribs, 6 mm
Thickness of base, 6 mm
Height of hub above base, 50 mm
Ribs are equally spaced.



END OF LESSON 13

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1715 DRAFTING 10

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PICTORIAL DRAWINGS

Pictorial Drawing

So far in this course we have considered working drawings in orthographic projection. When an object is represented in this way we always have two or more views which are detached from each other. The advantage of drawing these views is that they show clearly the true sizes and shapes of edges so that measurements can be made and dimensioning done relatively easily. However, they have one obvious disadvantage: the drawings do not give the best idea of what the finished article looks like.

The difficulty in drawing objects on paper is that objects in space have three dimensions whereas the paper has only two. We are all used to photographs and have come to accept photographs and what we see on the television screen as true representations of the original views. So realistic are they that we forget they are flat whereas the real people, houses, rooms, etc. they portray are solid objects in space.

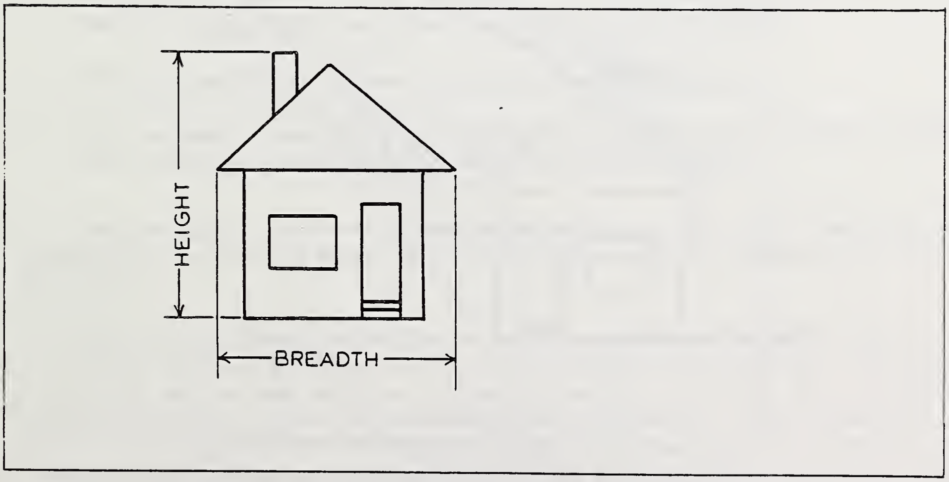
How does a photograph give the impression of three-dimensional space even though it is flat? It does it by means of perspective, and by highlights and shaded regions.

A drawing which, like a photograph, gives an impression of three-dimensional space, is called a **pictorial drawing**. The most realistic type of pictorial drawing is **perspective drawing**.

Perspective Drawing

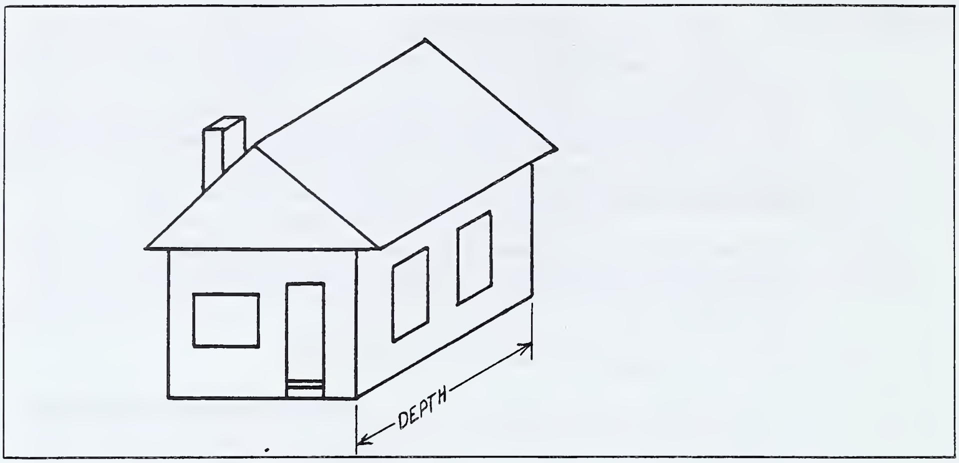
For purposes of drafting, perspective drawing has some disadvantages, but we shall consider it briefly to show how it gives the impression of space. Then we shall see how the device used to give this impression is retained in the pictorial drawings used in drafting while the disadvantages of perspective drawing are dispensed with.

If you look at the sheet of paper on which these words are printed you may consider the up-and-down (vertical) dimension as indicating height while the side-to-side (horizontal) dimension indicates breadth. Thus the front view of a house appears as shown below.

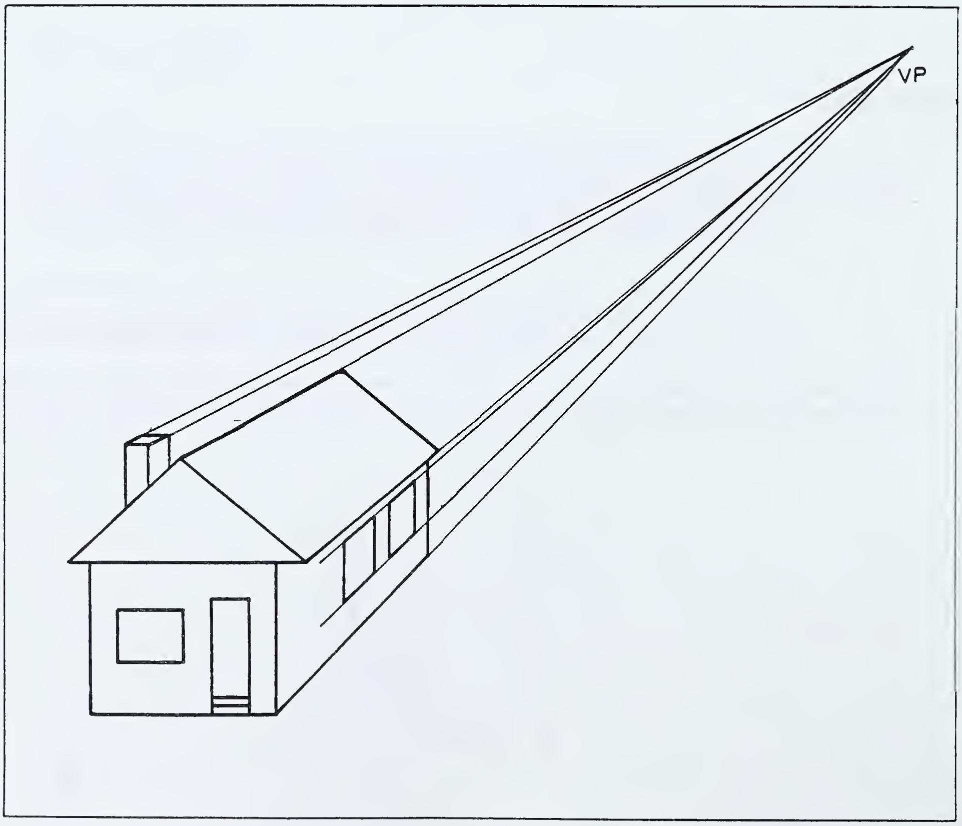


The portion of the house behind the front view must be shown by somehow fabricating another dimension which is really perpendicular to the plane of the paper.

We draw this dimension on the paper by drawing lines at an angle with the horizontal. All lines at this angle represent lines in the "depth" dimension.

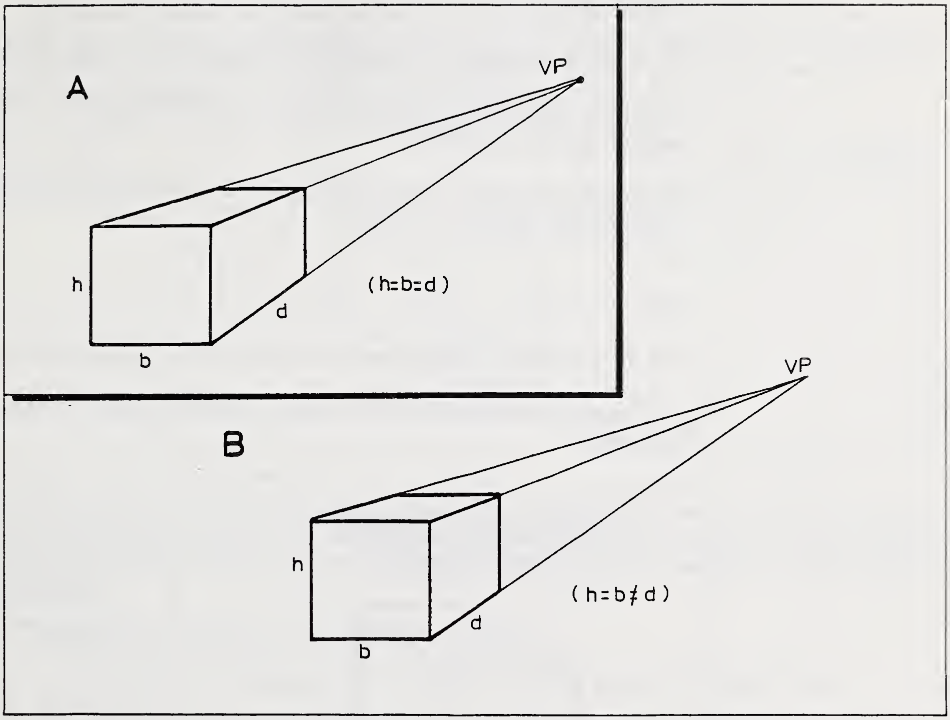


In a perspective drawing all the depth lines are at different angles so that they converge or come together like this:



The point at which all the lines in the depth dimension converge is called the **vanishing point**.

Now consider a cube (all edges of equal length) drawn in this way, as shown at A.



The cube at A looks, does it not, as if the edges along the depth were longer than either those of the height or breadth? To overcome this appearance, in a perspective drawing lengths along the depth dimension are foreshortened, that is, they are made less than the true length. The amount of this foreshortening may vary, according to the judgment of the maker of the drawing. The cube, drawn in perspective, looks as in B.

In a perspective drawing, then:

1. The third, or depth, dimension is shown at an angle with the horizontal.

2. The lines along the depth dimension converge to a vanishing point.

3. The true lengths along the depth dimension are foreshortened, gradually shrinking more and more for distances farther and farther from the observer.

The cube above was drawn in **one-point** perspective. One face of the cube was perpendicular to the line of sight of the observer but the cube was to his/her left and below eye level.

Corresponding to one-point perspective in drafting is **oblique projection**. Just as with one-point perspective, the object is drawn so that one face is perpendicular to the line of sight of the observer and the object is to his left and below eye level. Now for drafting purposes items 2 and 3 above are disadvantages since they prevent us from measuring true depth or true height in the plane which includes the third dimension. These disadvantages are overcome in oblique projection. There are two types of oblique projection called **Cavalier Projection** and **Cabinet Projection**. We shall now see how each of these overcomes the disadvantages of one-point perspective.

Oblique Projections

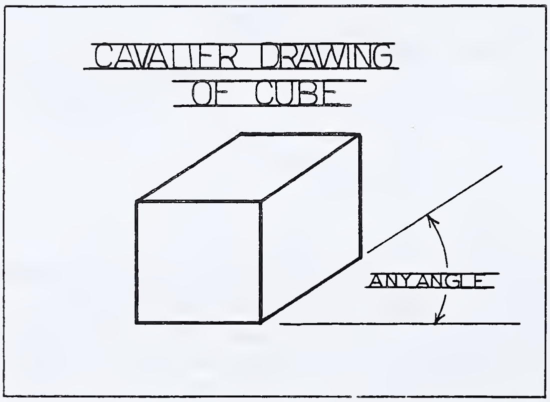
1. Cavalier Drawing

In cavalier drawing the two conditions for oblique projection are met:

1. The front face is drawn facing the observer just as it appears in orthographic projection and one-point perspective.
2. The depth dimension is represented by lines at an angle with the horizontal. (Any angle may be chosen.)

But:

1. All lines in the depth direction are parallel (so there is no vanishing point).
2. All lengths are retained as true lengths along the depth dimension. The cube appears like this:



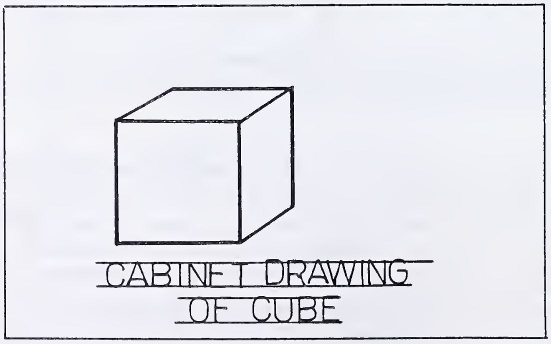
It is interesting to note that cavalier projections originated in the drawing of medieval fortifications, hence the name "cavalier" which can mean either a medieval soldier, or a raised fortified structure.

Pictures on old tapestries and pictures of the early forts in North America were drawn using this projection.

The obvious disadvantage of this projection is that objects appear to be deeper than they really are.

2. Cabinet Drawing

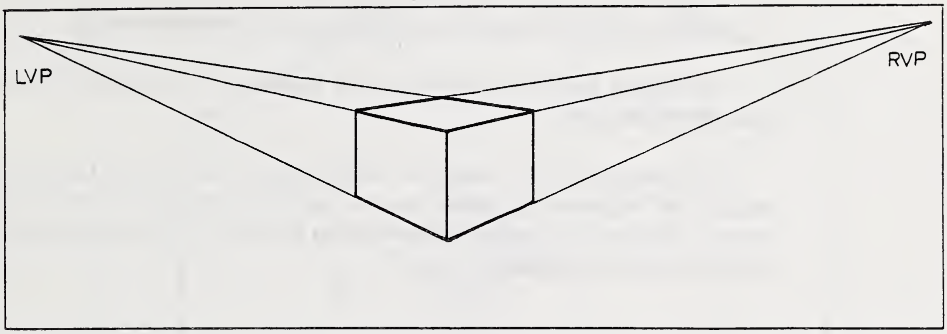
In this type of oblique projection exactly the same procedure is used as in cavalier drawing except that all lengths in the depth dimension are reduced to HALF SIZE.



This style of drawing originated in the furniture industry. It is a satisfactory method of depicting objects in which the front view is more important than the sides or top.

Two-Point Perspective

We have discussed one-point perspective drawing. If no face of a cube is perpendicular to the line of sight of the observer, then the cube must be represented by two-point perspective. Suppose a corner of the cube is directly in front of the observer but below eye level. Then the perspective drawing would be like this:



There are two vanishing points. Horizontal lines to the left of the front corner converge to the left vanishing point and horizontal lines to the right of the observer converge to the right vanishing point. Again, we have two disadvantages from the standpoint of the practical workman:

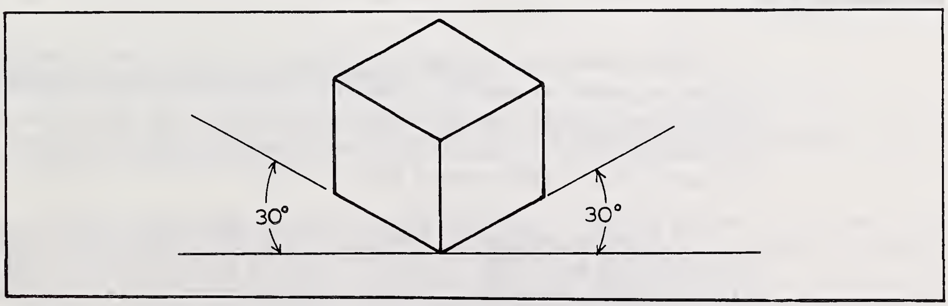
1. Horizontal distances are not shown true length.
2. Vertical distances are not shown true length except for those at the front corner.

However, the two-point perspective drawing gives a clear idea of the features of two sides and the top of the object. In isometric drawing we retain these advantages and eliminate the above two disadvantages.

Isometric Drawing

In isometric drawing:

1. One corner of the object is immediately in front of the observer.
2. Horizontal lines of the object on both the Left Side and the Right Side of this corner are all drawn at 30° to the horizontal on the paper.
3. All horizontal and vertical lengths on the object are shown true length on the drawing.



ISOMETRIC DRAWING OF A CUBE

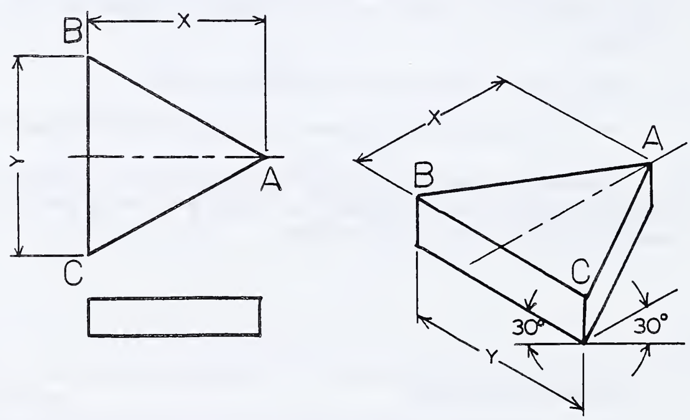
"Isometric" means "of each length." The advantage of this type of drawing is that all lengths which are vertical or horizontal in the original object appear as true lengths on the drawing. (Horizontal lines on the object are all tilted 30° to the horizontal on the drawing.)

On the other hand, any line which is NOT horizontal or vertical on the object does NOT appear true length on the isometric drawing.

All lines which are drawn true length are called **isometric lines.**

All oblique lines (lines which are not horizontal or vertical) on the object are called **non-isometric** lines.

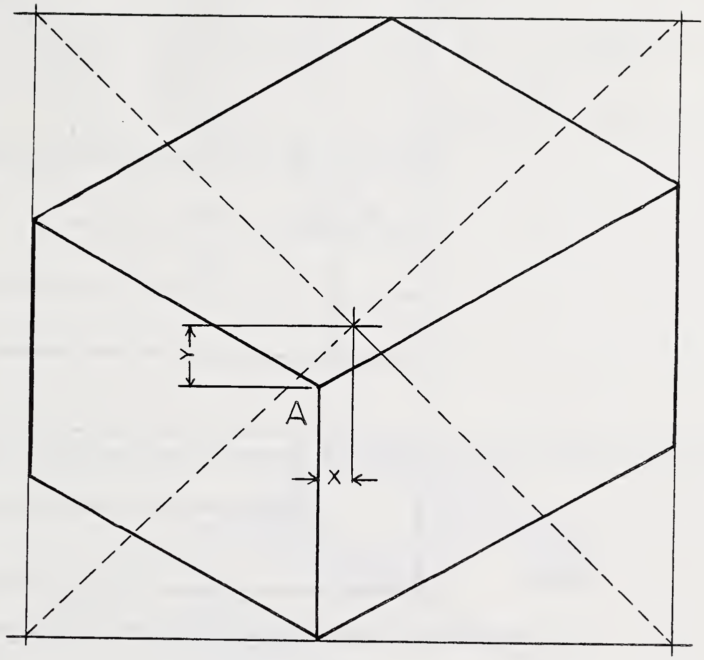
For example, in the isometric drawing shown below, the top face is an equilateral triangle. BC is drawn true length. But AC and AB represent the other two equal sides of the triangle. However, AC is plainly shorter than BC while AB is longer than BC in the drawing. AC and AB are non-isometric lines.



The Isometric Box

When an isometric drawing of an object is to be placed on a plate, the problem arises as to how to centre the drawing on the plate. Since the overall dimensions of the object are measured on an angle, you cannot find out from these what the extreme length and width of the drawing will be. To get this information, and as an aid in making the isometric drawing, we use the device of the isometric box.

For example, suppose we want to draw an object with overall dimensions: length 125 mm, width 100 mm, height 75 mm. Start with the front top corner A and locate it on a piece of scrap paper somewhat to the left of and below the centre of the paper. Now draw the complete outline of the box TO SCALE with intruments.



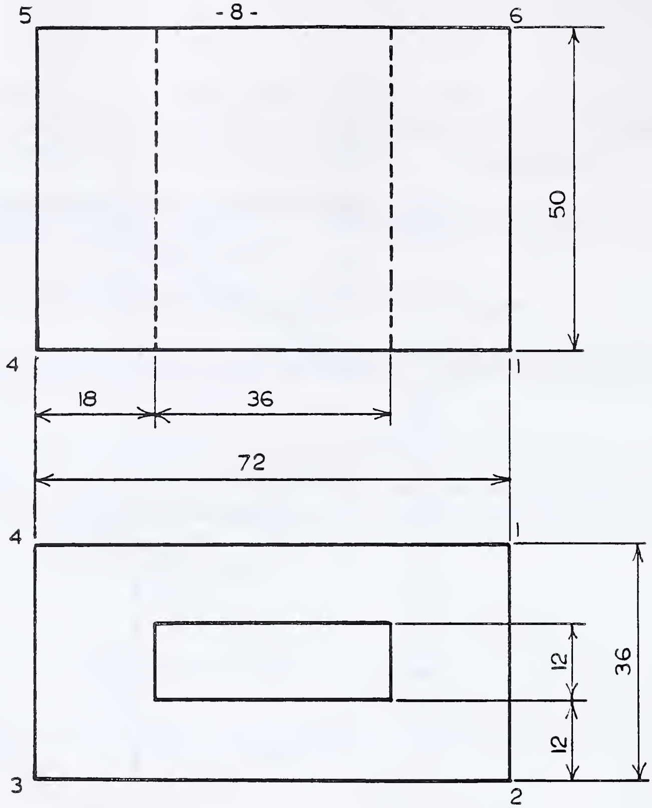
Enclose the isometric box in a rectangle which exactly contains the box. Find the centre of this rectangle by locating the point of intersection of its diagonals. Now measure to scale how far A is to the left of, and down from, the centre of the rectangle. Start your drawing on the plate by locating A these distances from the centre of the working space of the plate.

If the drawing is to be dimensioned, place the dimensions where required on the sketch of the object and enlarge your boundary rectangle to include them. Then find the centre of the rectangle as before. We shall discuss the dimensioning of isometric drawings in more detail in Lesson 15.

How to Make an Isometric Drawing, Given Orthographic Views

For reference, the corners of the object have been numbered. (Note that edge 1-4 shows in both top and front views.)

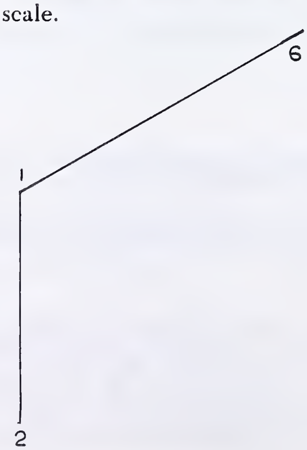
We shall make the isometric drawing with edge 1-2 directly in front of the observer. Use these instructions to enable you to draw the object first on scrap paper to scale, roughing in the main features of the object. Then use the rough drawing to get the measurements required for centering the final drawing on the plate. Attach the scrap paper to your drawing board so that you can get angle and length measurements reasonably accurate.



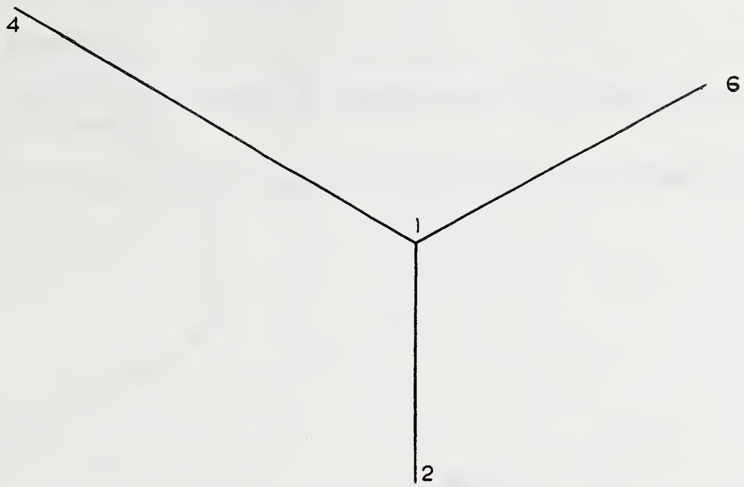
Steps:

1. Draw edge 1-2 to scale slightly to the right of and below the centre of your scrap paper.

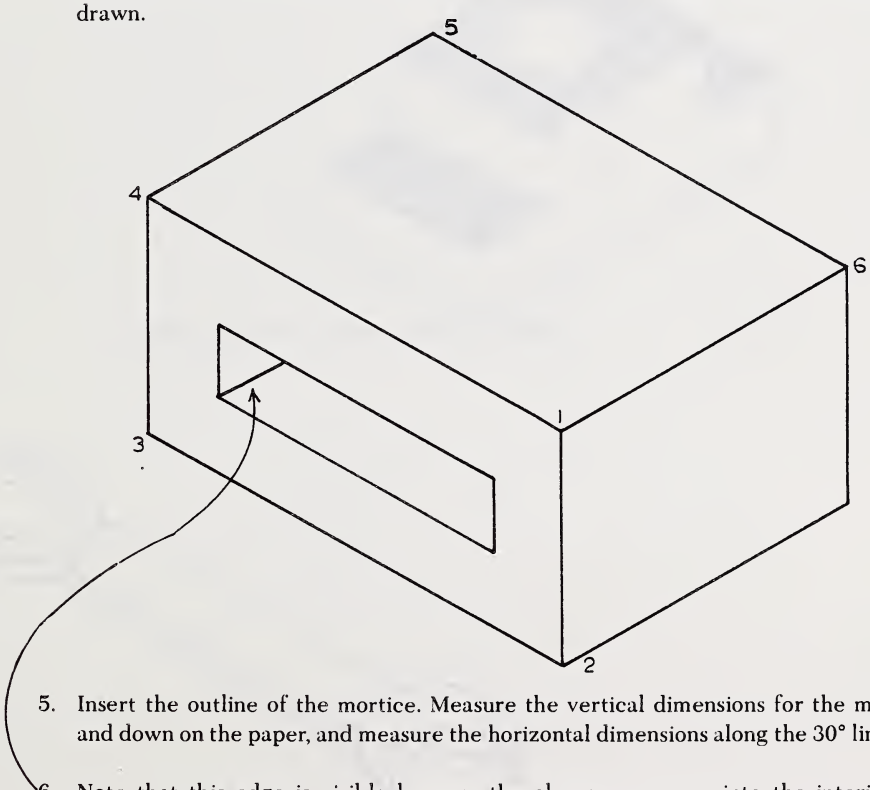
2. Draw edge 1-6 at 30° using the T square and 30° - 60° triangle. Draw it the correct length to scale.



3. Draw edge 1-4 to scale also at 30°.



4. Complete the isometric box by drawing the remaining edges parallel to those already drawn.



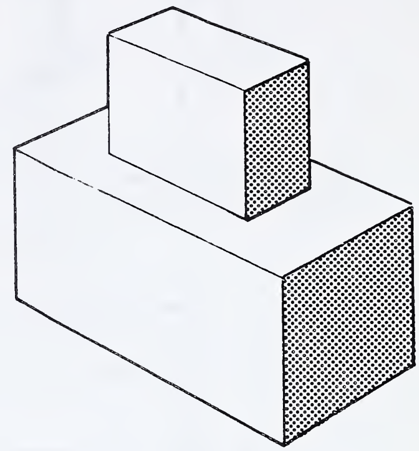
5. Insert the outline of the mortice. Measure the vertical dimensions for the mortice up and down on the paper, and measure the horizontal dimensions along the 30° line.

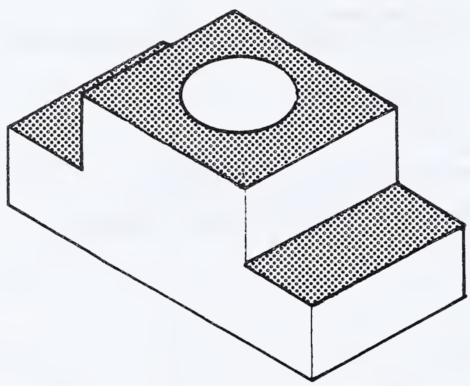
6. Note that this edge is visible because the observer can see into the interior of the mortice.

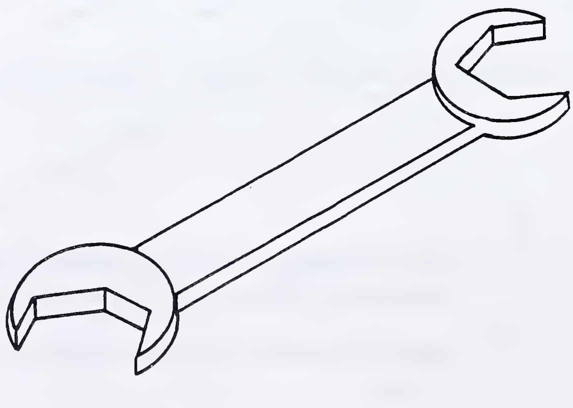
7. OMIT ALL HIDDEN EDGES.

8. After the object has been drawn thus on scrap paper, dimensions are inserted and then the whole drawing is measured for centering on the plate.

SOME EXAMPLES OF ISOMETRIC DRAWING







EXERCISES TO BE SENT IN FOR CORRECTION

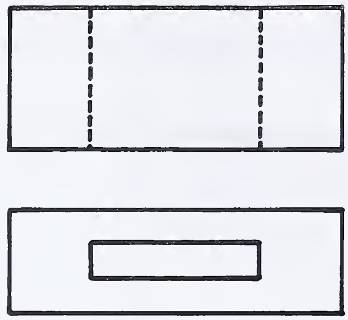
EXERCISE 1: Oblique Projection

In the spaces provided draw the sketches called for. They need not be to scale but keep the sizes in proportion.

1. (a) Make a cavalier drawing of a rectangular block 40 mm × 50 mm × 80 mm.

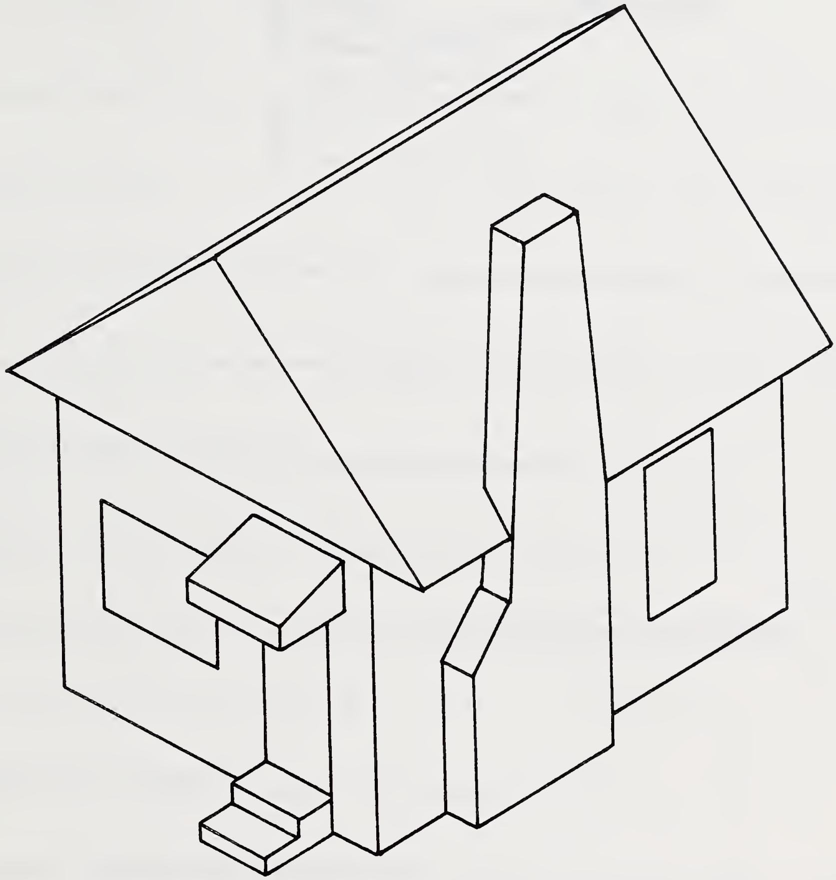
   (b) Make a cabinet drawing of the same block.

2. Make a cabinet drawing of the Mortised Piece using the same Front View as is given in the Orthographic Projection shown below.

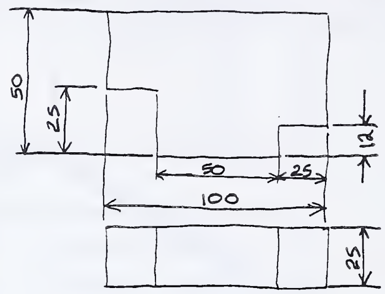


EXERCISE 2: Isometric and Non-Isometric Lines

1. Examine the drawing below and pick out all the non-isometric lines on it. Letter an N through each non-isometric line you find, like this: N



2. Make a ONE-POINT perspective drawing of the following block. Clearly show the vanishing point.



EXERCISE 3: Review of Facts About Pictorial Drawings

From the six words given below, choose the one which applies to each of the following sentences, and write it in the blank space provided.

Cabinet	Isometric	Orthographic
Cavalier	Oblique	Perspective

1. Has converging lines. ______________________

2. Shows hidden edges. ______________________

3. Cabinet and Cavalier drawings are each ______________________

4. Receding lines are half actual measurement. ______________________

5. Has foreshortened vertical lines. ______________________

6. Requires a 30° - 60° triangle. ______________________

7. Has horizontal, vertical, and oblique lines on one of the side views in true length.

   ____

8. Makes the truest picture. ______________________

9. Surfaces are equally inclined to the observer. ______________________

10. Surfaces are squarely set before the observer. ______________________

11. A drawing with three detached views. ______________________

12. Box construction very helpful. ______________________

13. Involves isometric and non-isometric lines. ______________________

14. Object appears longer and deeper than it really is. ______________________

EXERCISE 4: Isometric Drawing

For this lesson we shall omit dimensioning and drawing on plates. Instead, we shall ask you do draw the isometric drawings in the spaces provided in this exercise. Then in the NEXT lesson you will add dimensions to the drawings and transfer them to plates.

The printed exercise page should be removed from the lesson book and attached to your drawing board. Do the drawings with the T square, 30° - 60° triangle, and measuring scale. These are preliminary drawings, not finished plates, so the lines and measurements can be just roughed in with 4H or H pencil, whichever you prefer.

1. Make an isometric drawing of the Half Lap.

   Length, 75 mm

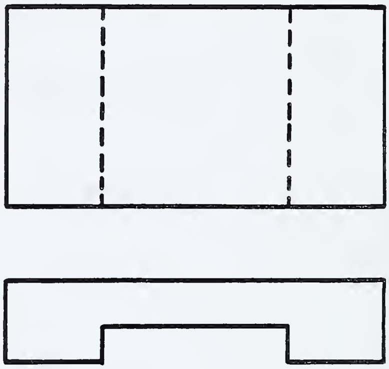
   Width, 50 mm

   Overall height, 18 mm

   Depth of slot, 9 mm

   Distance from edge to side of slot, 18 mm

   Slot is centred in the length.



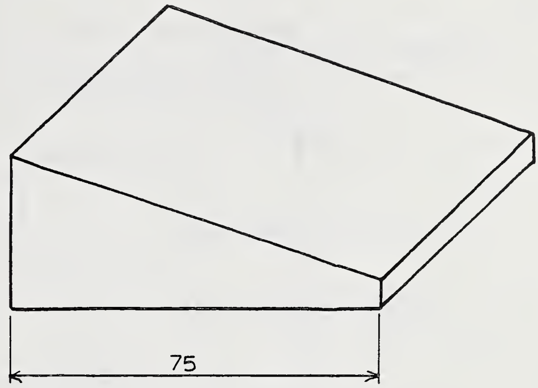
2. Make an isometric drawing of the Wedge.

Length, 75mm

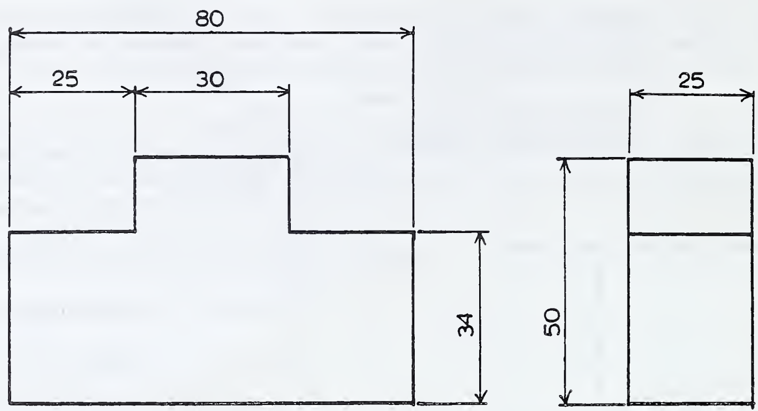
Width, 43 mm

Height at thick end, 29 mm

Height at thin end, 6 mm



3. Make an isometric drawing of the T Block from the Orthographic drawing given below.



END OF LESSON 14

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Assignment Code: ________

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DIMENSIONING ISOMETRIC DRAWINGS

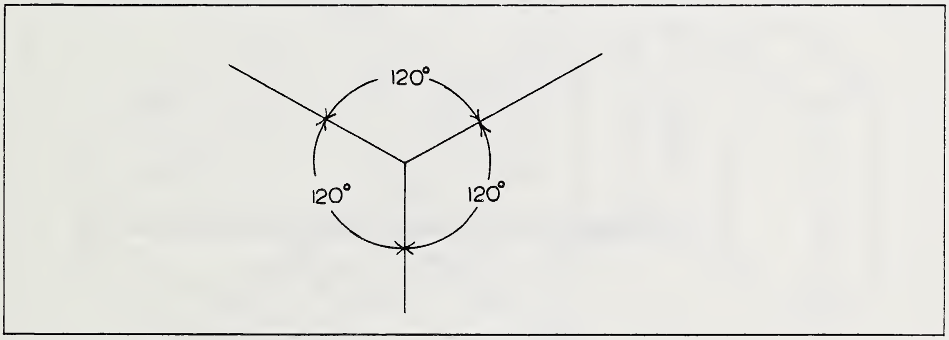
The dimensioning of isometric drawings is done by using extension and dimension lines just as is the case with views in orthographic projection. These rules apply to both types:

1. The shortest dimensions are placed nearest to the object, longer ones are placed farther out.

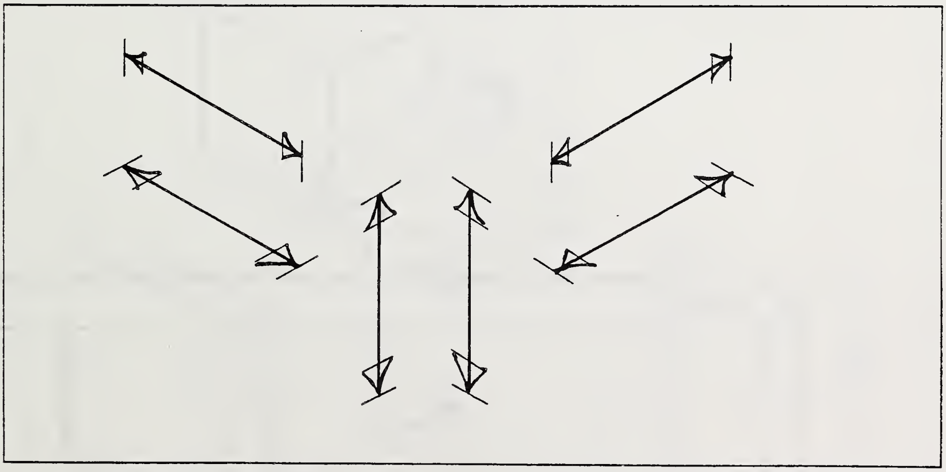
2. No measurement is repeated unnecessarily.

3. Dimensions are located outside the object where possible, and so that extension lines do not cross dimension lines.

There is, however, one important difference between the dimensioning of orthographic projections and the dimensioning of isometric drawings. In isometric drawings, extension and dimension lines are always PARALLEL to one or the other of the isometric axes. Since none of these is horizontal, there are NO horizontal extension or dimension lines on an isometric drawing. The three axes are like this,



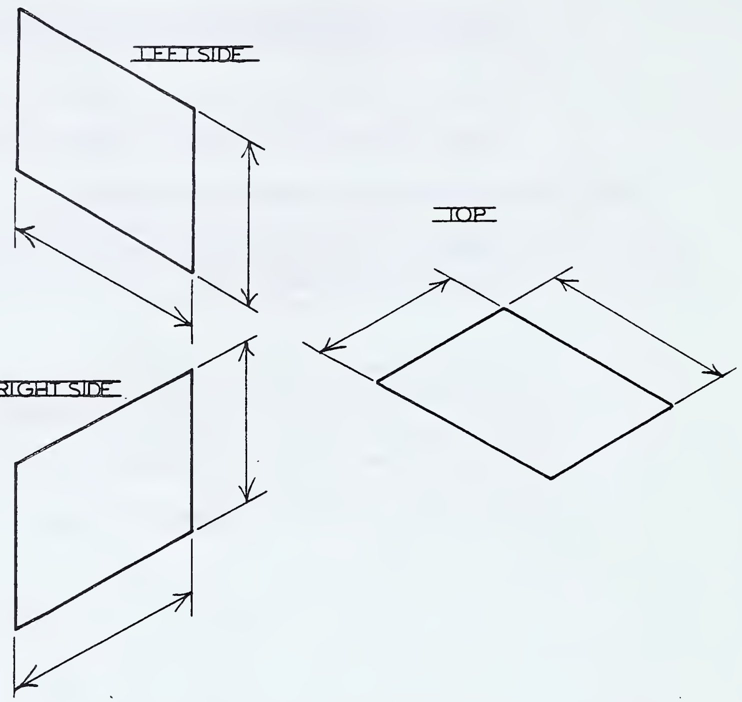
so the dimension and extension lines will appear in any of these possible ways:



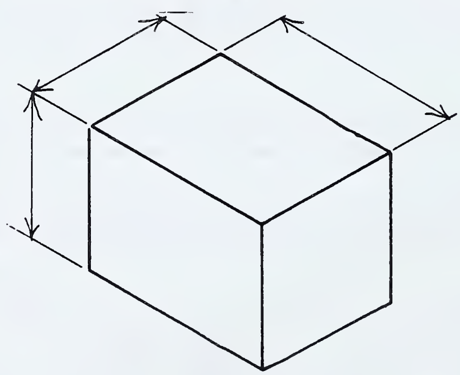
The extension lines are ALWAYS in the direction of the edges from which the measurements are taken.

The dimension lines are PARALLEL to the edge whose measure is shown.

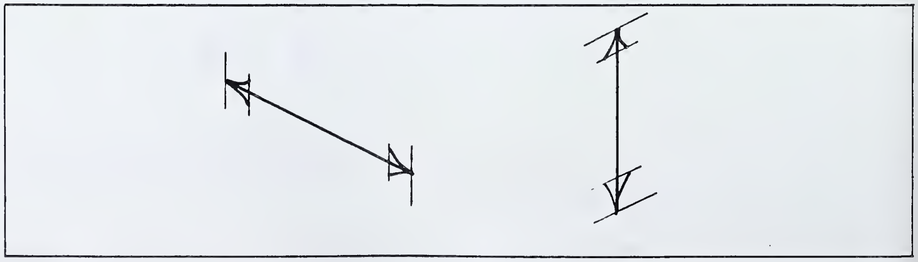
Let us take each face of an isometric box in turn and see which set of extension and dimension lines to use to measure each of its two dimensions.



A simple isometric box would be dimensioned like this:

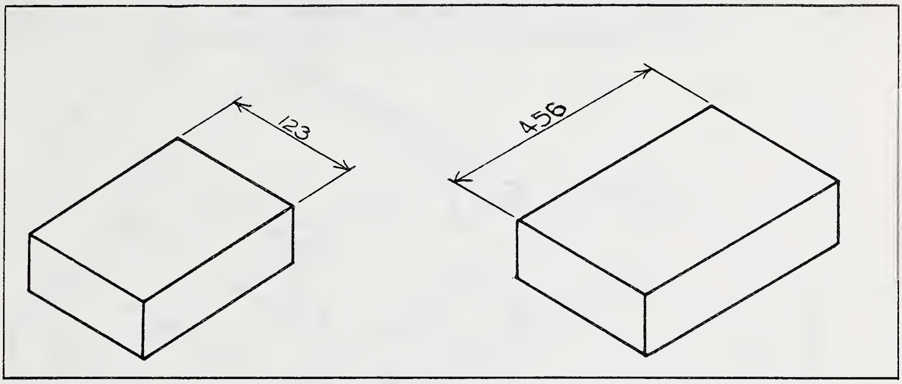


Observe that the ends of the barbs of the arrowheads line up parallel to the extension lines.

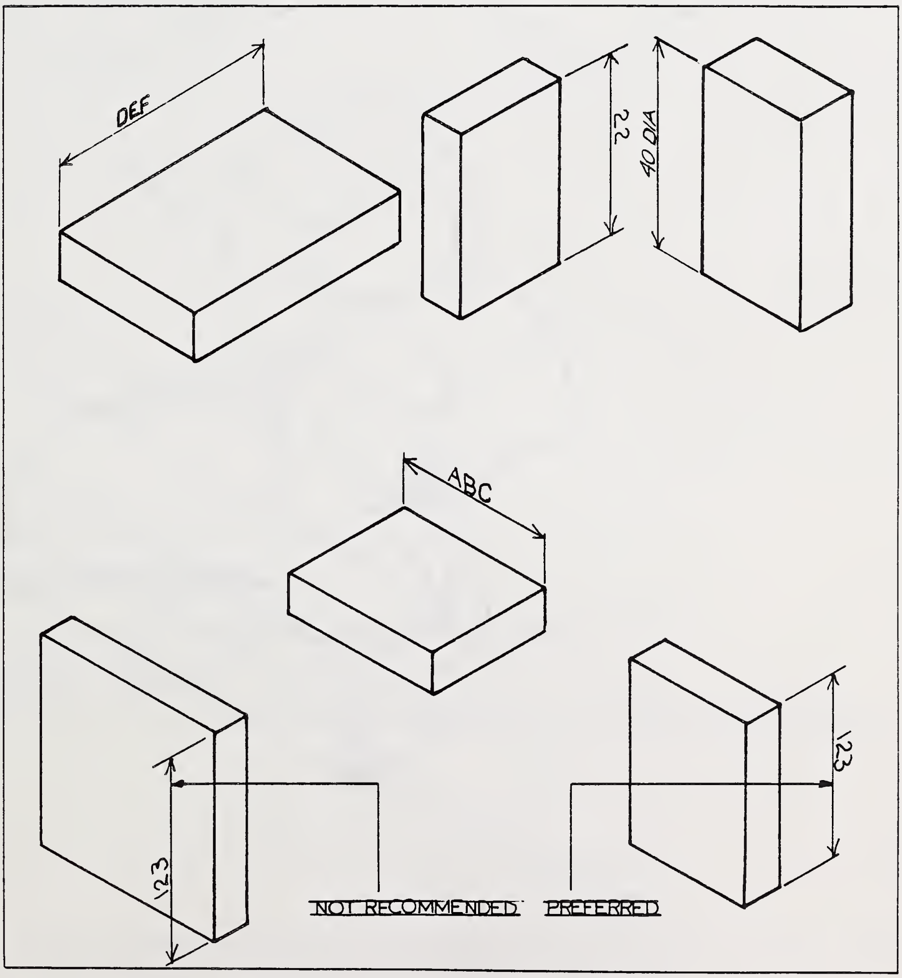


Lettering

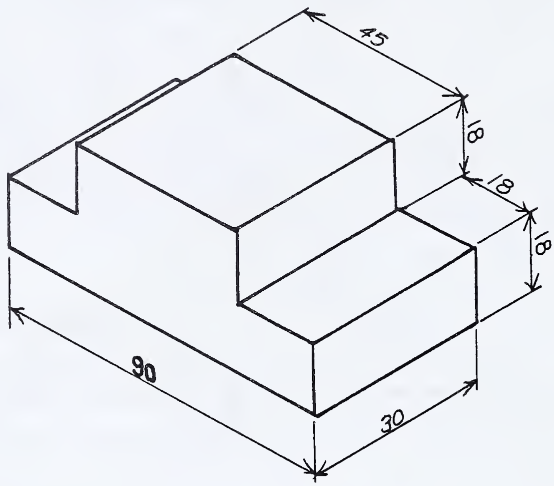
The lettering used with these lines must be slanted to conform with the slant of the extension lines, like this:

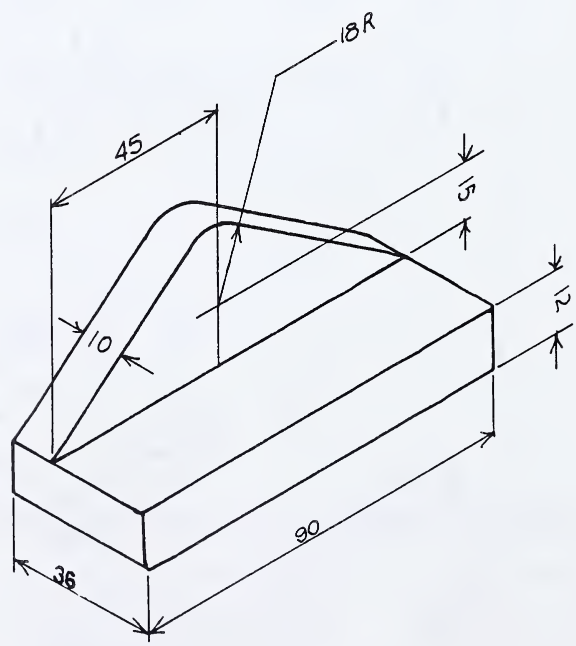


Also, all lettering is done so that it can be read from the BOTTOM of the drawing.



SOME EXAMPLES SHOWING CORRECT ISOMETRIC DIMENSIONING



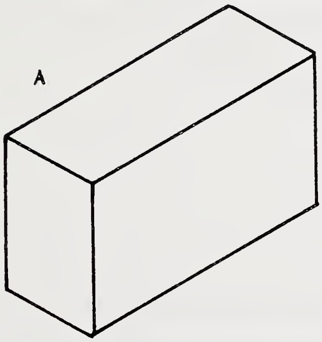


EXERCISES TO BE SENT IN FOR CORRECTION

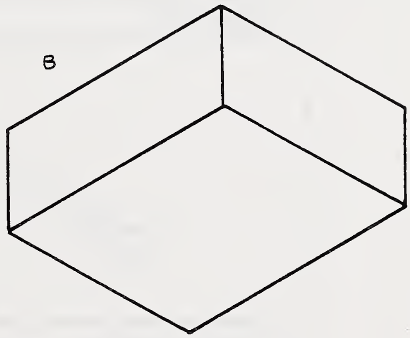
EXERCISE 1: Extension and Dimension Lines in Isometric Drawings

Supply the extension and dimension lines needed to dimension each of the following isometric drawings. Place arrowheads on the ends of each dimension line.

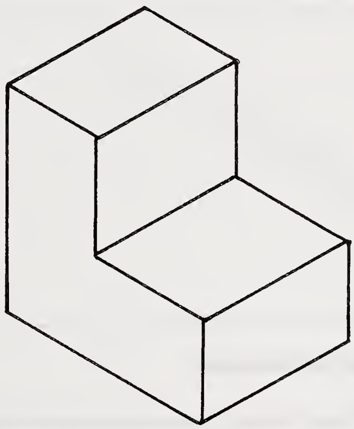
A



B



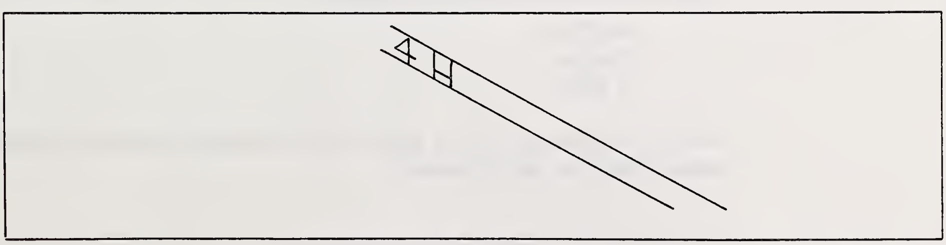
C



EXERCISE 2: Lettering on Isometric Drawings

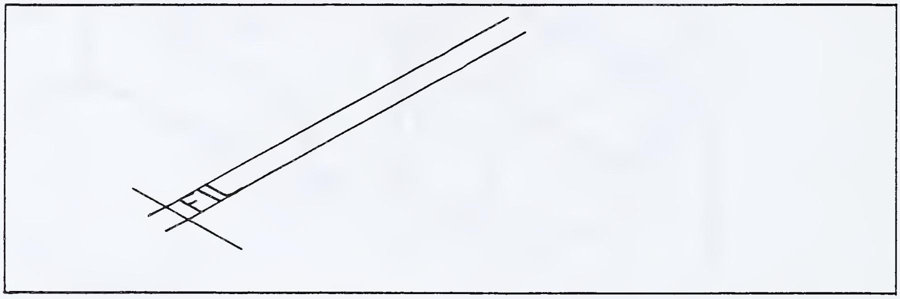
Complete each of the following with the lettering called for.

1. 4 holes — 5 drill

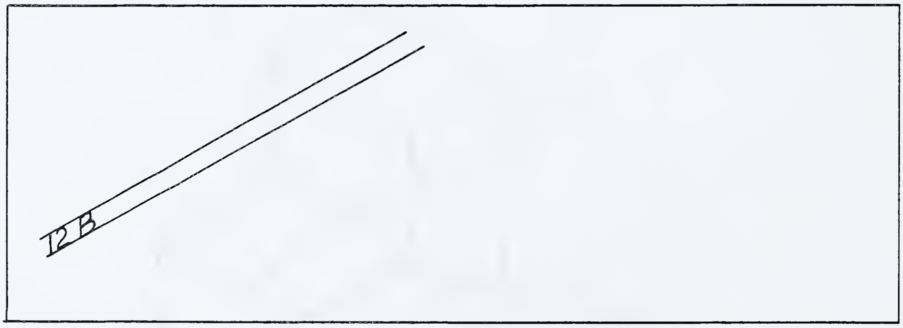


2. 115 dia

3. Fillets 12R



4. 12 bore — 3 holes



EXERCISE 3: Completed Isometric Drawings

1. Place all the necessary dimensions on the drawings you made at the end of Lesson 14 by inserting the required extension and dimension lines and lettering the measurements.

2. Enclose each drawing in a rectangle which contains within it the dimensions and find the centre of the rectangle as explained in Lesson 14.

3. Use three prepared plates and on them, make the three isometric drawings complete with dimensions, called for in Lesson 14:

   Half Lap
   Wedge
   T-Block

   Locate the drawings on the plates by the centering method explained in Lesson 14. Make all lines the correct weight.

END OF LESSON 15

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

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BLUEPRINT READING: METHODS OF MAKING HOLES

Methods of Making Holes

Shop operations to be done on the object are indicated on the drawing itself. For instance, you are already acquainted with the indication for finished surfaces on a drawing. Also, the method of making holes is indicated. Six kinds of holes are in common use on machine parts.

1. Cored — left rough in the casting
2. Drilled — bored in a lathe or mill
3. Reamed — reamed with a reamer; accurate
4. Broached — broached with a broach; very accurate
5. Tapped — threaded with a tap

The method used may be indicated by a leader as shown in the diagram in Exercise 4 (Tool Stop) or by a word along the dimension line as shown in Exercise 2 (Cap Nut).

1. Cored Holes

The cored hole is part of the casting. The hollow region required for the hole in the casting is obtained by placing a core of sand, which is baked hard, within the mold where the hole is to be located. When the molten metal is poured into the mold this space will be plugged by the core. After the casting has hardened, the core is removed, leaving the required hole.

2. Drilled Holes

This type of hole is made with a twist drill such as may be found in your home workshop. Holes made in this way are of limited accuracy both as to position and size of hole. When greater accuracy is required, one of the following methods may be used.

3. Bored Holes

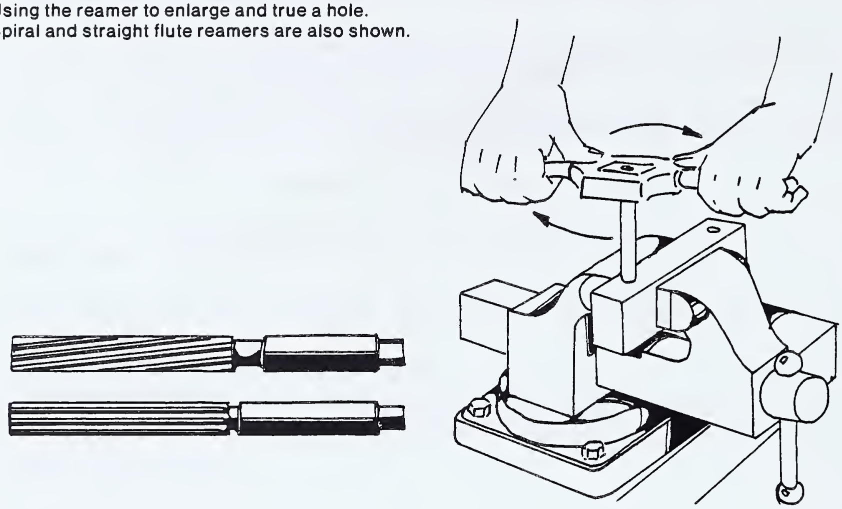
The hole is first drilled undersize. Then a boring tool is inserted in the hole. This tool scrapes the side of the hole to the exact width set on the scraping blade. The boring is done on a lathe or mill. This means that the object is made to revolve while the boring tool remains stationary.

A cored hole may also be finished by boring if it is made sufficiently undersize in the mold.

4. Reamed Holes

A reamer is used to enlarge and improve the surface of a drilled or bored hole. The reaming tool has long blades parallel to the axis of the hole and smooths the surface in somewhat the same way as a plane smooths the flat surface of a board.

Using the reamer to enlarge and true a hole.
Spiral and straight flute reamers are also shown.



5. Broached Holes

Broaching is similar to a single-stroke filing operation. The broach is inserted into the drilled hole. It consists of a succession of teeth each of which bites deeper and deeper into the metal. As each tooth shaves off a very fine thickness of metal, great accuracy is obtained in the finished work. Diameters accurate to over one ten-thousandth of an inch may be obtained. The cross section of the broach may have whatever shape is required for the final hole — square, rectangular, hexagonal, etc. For this reason keyways are made with this tool.

6. Tapped Holes

The hole is first drilled. Then the tap is used to cut a thread in the hole for use with a screw or other form of threading plug.

EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Saw Table

1. The depth of hole A is ________________.

2. The diameters of the circles in the drawing below are

   A =   C =

   B =   D =

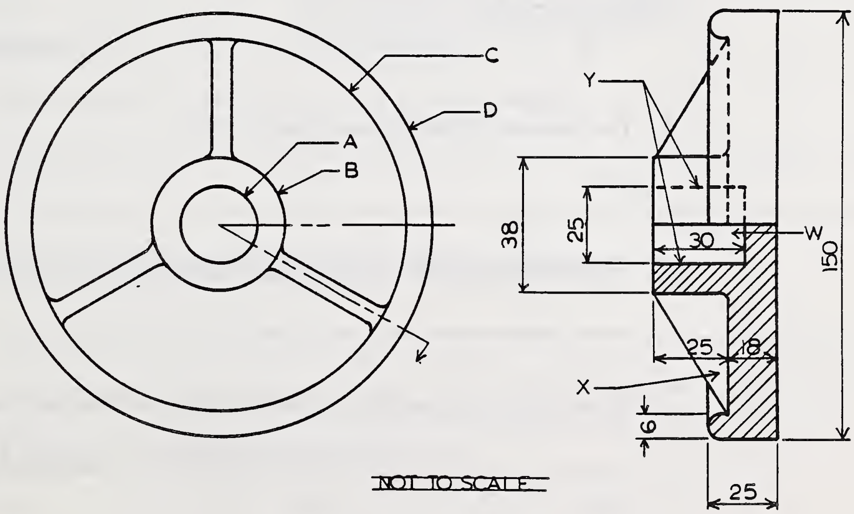
3. What kind of section is depicted by the lower half of the right-hand view?

   ____

4. Why is surface X not cross-hatched? ______________________

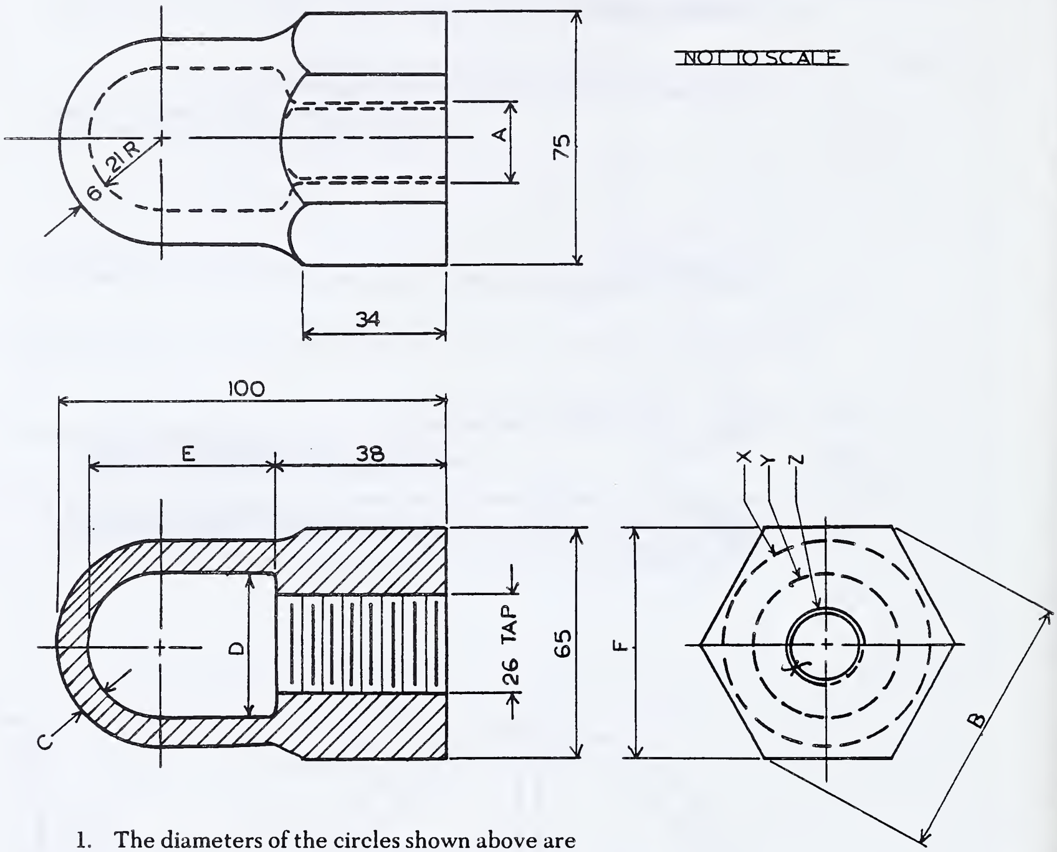
   ____

   ____



1: SAW TABLE

EXERCISE 2: Cap Nut



1. The diameters of the circles shown above are

   X = Y = Z =

2. Why are there double lines through the hexagonal part in the front view?

   ____

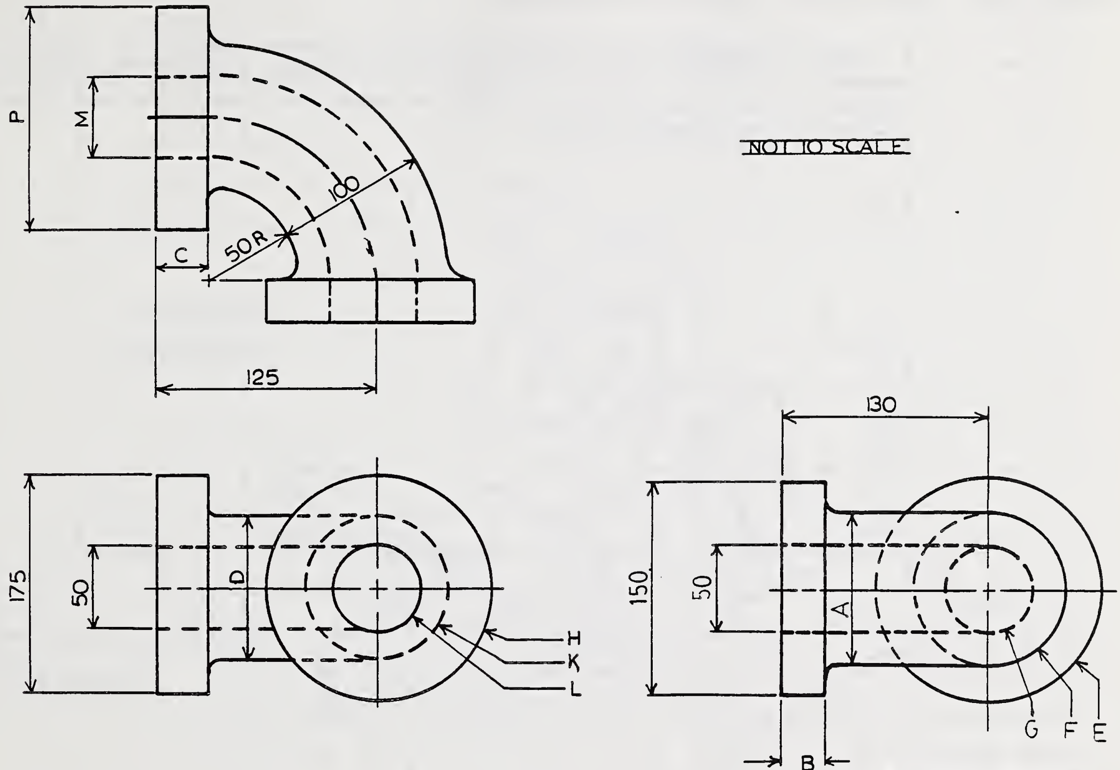
3. What do the corresponding vertical lines in the bottom view indicate?

   ____

4. How is the threaded part made? ______________________________

5. A = C = E =

   B = D = F =



3: FLANGED ELBOW

EXERCISE 3: Flanged Elbow

1. Why is circle H a full line and circle E partly dotted?

____

____

2. Why is circle K a dotted line and circle F shown partly in full?

____

____

3. The diameters of the circles shown below are:

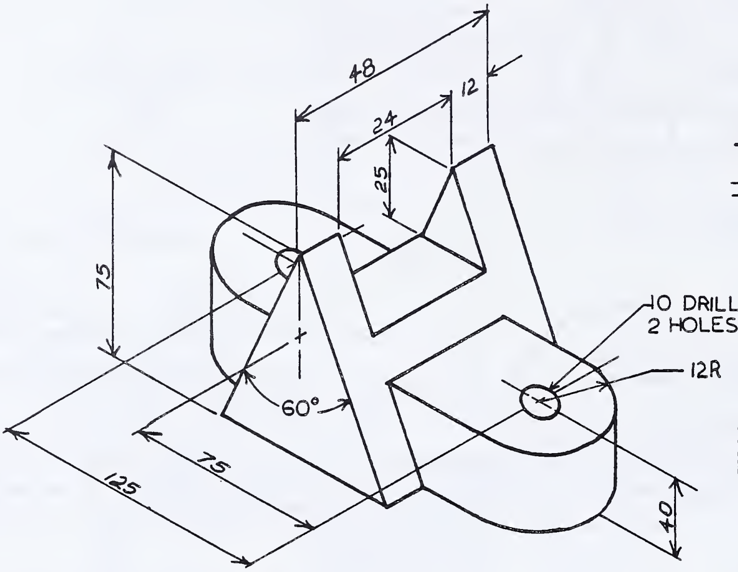
E =	G =	K =
F =	H =	L =

4.

A =	C =	M =
B =	D =	P =

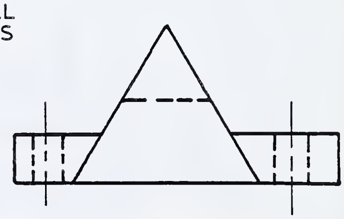
EXERCISE 4: More Practice in Orthographic Sketching

Make orthographic 3-view sketches of each of the objects below. Use the squared paper provided and show all necessary dimensions. The front view is already given. Copy it and supply the other two views. It would also be very helpful for students to review Exercise 5 of Lesson 8 before starting this exercise.

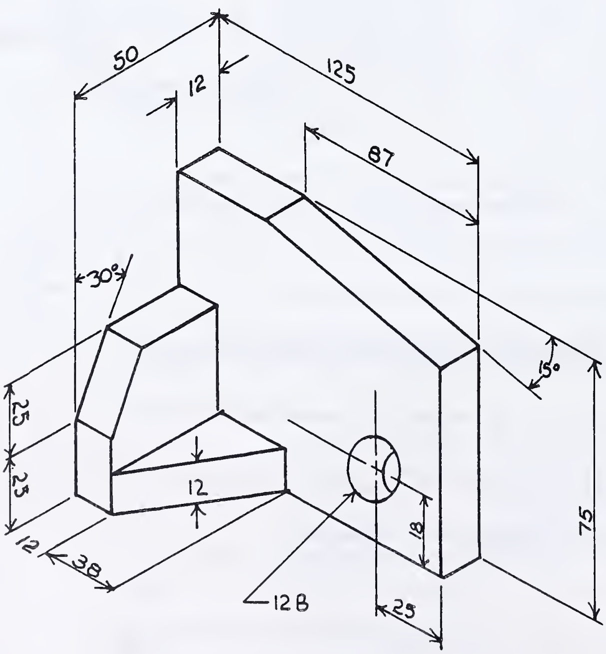


TOOL STOP

NOT TO SCALE

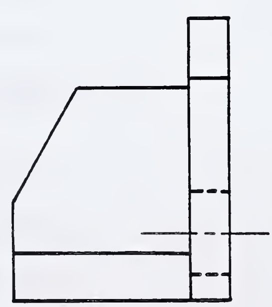


FRONT VIEW



BRACKET

NOT TO SCALE



FRONT VIEW

END OF LESSON 16

★ ★ ★ ★ ★

END OF 4-CREDIT COURSE

★ ★ ★ ★ ★

DRAFTING 10

Lessons 17 through 20

(for students in the 5-credit course)

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

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PRODUCING DRAWINGS TO ENLARGED AND REDUCED SCALE

Suppose you had to make a drawing of a boat. If you drew it actual size, the paper would be so large it would be very inconvenient to use. You would have to draw the boat much smaller than it really is. But how much smaller would you draw it?

Suppose the boat was 40 m long. You could, on your paper, draw it 40 cm long. Your picture would be 1/100th the size of the actual boat. This drawing would then be called a "SCALE" drawing.

Types of Scales

A scale indicates the ratio between the actual length of lines in a drawing and the true measurements of the object drawn. The scale of a drawing may be expressed in one of three ways:

1. Full Scale (1:1)

The first digit in the ratio always refers to the scale drawing, the second digit of the ratio refers to the true size of the object.

Full scale indicates that the object is drawn at its actual size, as in the size of various mechanical parts.

2. Enlargement Scale (e.g. 2:1, 5:1, 10:1, etc.)

This means that the object (such as a small watch part) is drawn larger than its acutal size. A 2:1 scales shows lengths twice their true size lengths.

3. Reduction Scale (e.g. 1:2, 1:5, 1:10, etc.)

This represents the reduction in size of objects too large to be shown true size on a drawing.

4. Recommended Scales

The Canadian Government Standards Branch (CGSB) standard 88-GP-20M specifies scales and ratios recommended for use on engineering drawings, on architectural and construction drawings, and for surveying and mapping purposes. The chart on the following page indicates these recommended ratios.

x = indicates usage of a particular scale for the purpose shown.

SCALES (RATIOS) FOR USE WITH THE METRIC (SI) SYSTEM	ENGINEERING	ARCHITECTURAL & CONSTRUCTION	SURVEYING & MAPPING
REDUCTION			
1 : 1 000 000			x
1 : 500 000			x
1 : 250 000			x
1 : 200 000			x
1 : 100 000	x		x
1 : 50 000	x		x
1 : 25 000			x
1 : 20 000			x
1 : 10 000	x		x
1 : 5 000	x		x
1 : 2 000	x	x	x
1 : 1 000	x	x	x
1 : 500	x	x	x
1 : 200	x	x	x
1 : 100	x	x	x
1 : 50	x	x	x
1 : 20	x	x	
1 : 10	x	x	
1 : 5	x	x	
1 : 2	x		
FULL SCALE			
1 : 1	x	x	
ENLARGEMENT			
2 : 1	x		
5 : 1	x		
10 : 1	x		
20 : 1	x		
50 : 1	x		
100 : 1	x		

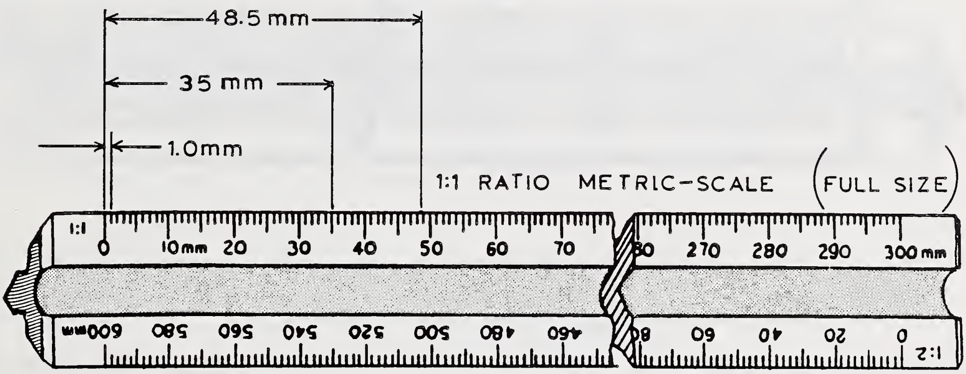
The scale used in drawing should be stated in the title panel of each drawing sheet, e.g., SCALE 1:1000. Full-scale drawings are denoted by SCALE 1:1. The notation NOT TO SCALE or N.T.S. may be used on drawings which are not drawn to any particular scale.

Using Metric Scales

The metric scale is used when the metre is the standard for linear measurement. Metric scales are available in flat and triangular styles with a variety of scale graduations. The simplicity of the metric system is reflected by the ease with which metric ratios can be manipulated. The triangular scale illustrated below has one full-size scale and five reduced-size scales, all fully divided. By means of these scales a drawing can be made full size, enlarged size, or reduced size.

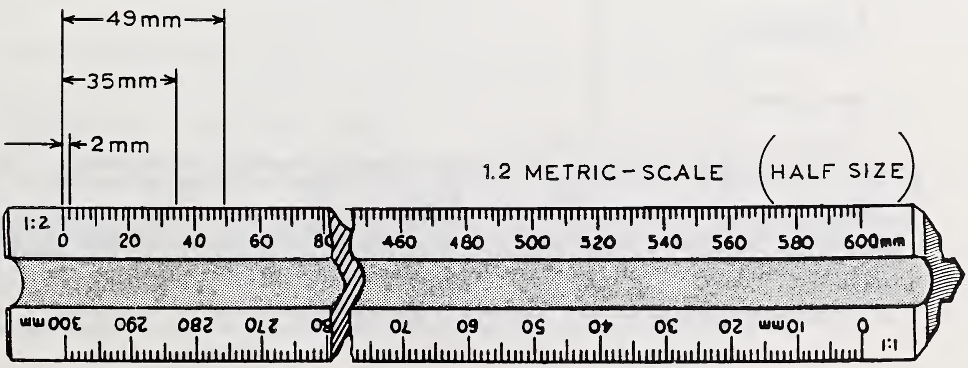
Full Size

The 1:1 scale is full size and each division is 1 mm in width with the numbering of the calibrations in 10 mm intervals. This same scale is also convenient for the ratios of 1:10, 1:100, 1:1000, etc.



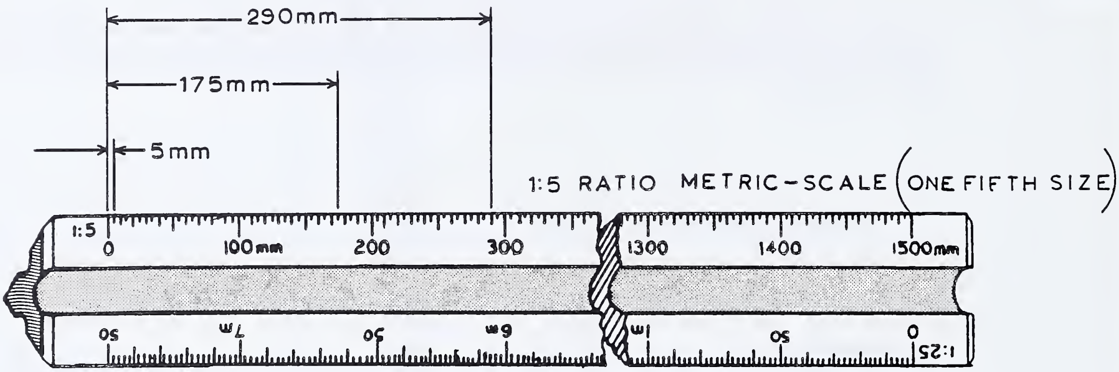
Half Size

The 1:2 scale is one-half size and each division equals 2 mm with the calibration numbering at 20 unit intervals. This scale is convenient for ratios of 1:20, 1:200, 1:2000, etc.

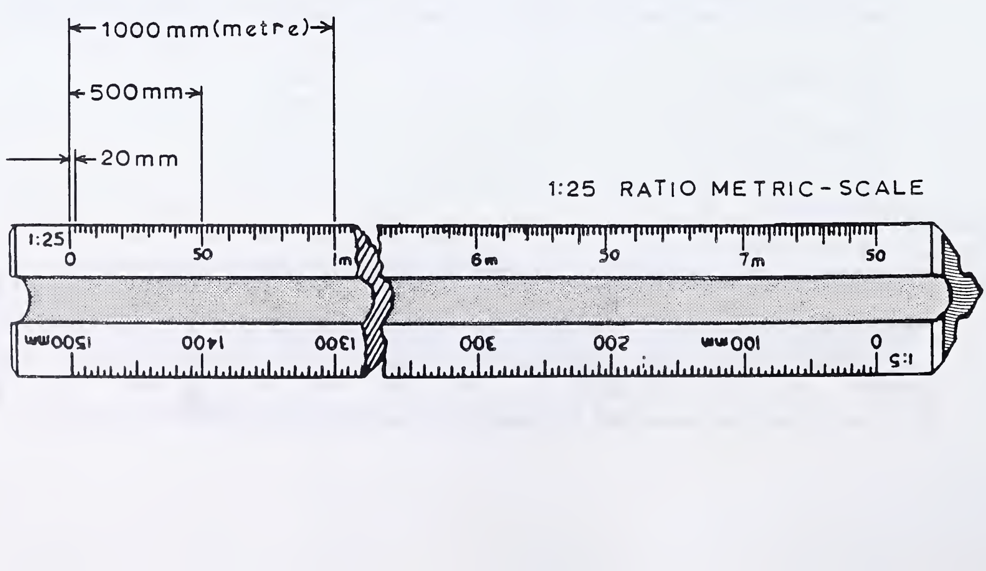


One-Fifth Size (1:5)

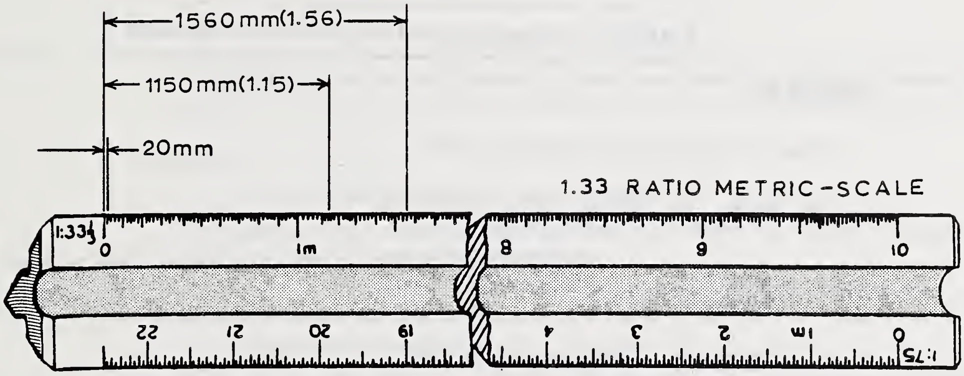
The ratios may also be enlarged or reduced as desired by multiplying or dividing by a factor of 10.



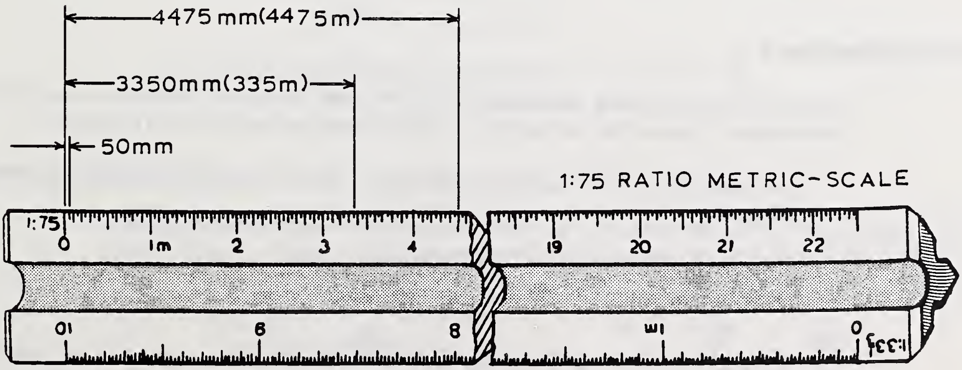
One-Twenty-fifth Size (1:25)



One-Thirty-third Size (1:33⅓)



One-Seventy-fifth Size (1:75)



NOTE: If you plan to follow the chart shown on page 2, the 1:33$^1/_3$ and 1:75 scales of a triangular scale are not used.

Probably the most difficult part of doing scale drawings lies in the required mathematics. To help you out we have supplied the following theory and exercises on Ratio and Proportion which will serve as an introduction to scale drawings.

Ratios

A RATIO is a comparison of two numbers by division.

EXAMPLES:

1. There are 24 boys and 16 girls in a class.

   (a) Ratio: $\frac{24}{16}$ (This is read as "twenty-four to sixteen.")

   The above fraction expresses the ratio of the number of boys to the number of girls in the class.

   (b) Ratio: $\frac{16}{24}$ (This is read as "sixteen to twenty-four.")

   The above fraction expresses the ratio of the number of girls to the number of boys in the class.

   When a fraction is used to indicate a ratio, we call the denominator the **base**. The base is always the number to which you bring the other number for comparison. (The base follows the word "to.") The base is the number we are dividing by since the fraction bar indicates division.

   In the ratio $\frac{24}{16}$ the base or denominator is 16. The numerator is 24.

   In the ratio $\frac{16}{24}$ the base is 24. The numerator is 16.

Self-Correcting Exercise #1

In each of the following problems, write the ratio specified. Remember that the base, or denominator, comes after the word "to." The answers for can be found on page 12.

1. Jim weighs 61 kg and George weighs 68 kg. What is the ratio of Jim's weight **to** George's weight?

   $\frac{\text{Jim's weight}}{\text{George's weight}} = \_\_\_\_\_$ The base or denominator is _____ .

2. A field measures 650 m long by 420 m wide. The ratio of the length to the width = _____ .

   The ratio of the width to the length = _____ .

3. A water tower is 32 m high and 5 m in diameter.

   The ratio of the diameter measure to the height = ——— .

4. John is 16 years old. His father is 40 years old.

   The ratio of the father's age to John's age = ——— = ——— (simplest form).

Proportions

A PROPORTION is a statement in which two fractions name the same ratio.

EXAMPLE: $\frac{1}{2} = \frac{3}{6}$

The second ratio reduced to simplest form is the first ratio. We call fractions that name the same number **equivalent fractions.**

If two ratios are equal, as in a proportion, the cross products are equal.

$\frac{1}{2} \times \frac{3}{6}$

$1 \times 6 = 6$
$2 \times 3 = 6$ } These are **CROSS PRODUCTS.**

In our proportion the cross products are equal so we know that we have a proportion (i.e. $1 \times 6 = 2 \times 3$).

Consider two ratios which are not equivalent so do not form a proportion.

$\frac{3}{4} \neq \frac{2}{3}$ (The symbol "$\neq$" means "is not equal to.")

Checking the cross products we have:

$\frac{3}{4} \times \frac{2}{3}$

$3 \times 3 = 9$
$4 \times 2 = 8$

The cross products are not equal since $3 \times 3 \neq 4 \times 2$.

Self-Correcting Exercise #2

Decide which of the following statements are true by using the cross-product check. Then, write "True" or "False" in the upper blank. The answers can be found on page 12.

(a) $\frac{3}{4} \stackrel{?}{=} \frac{9}{16}$ false

Check:

$3 \times 16 \stackrel{?}{=} 4 \times 9$

$48 \neq 36$

(b) $\frac{5}{8} \stackrel{?}{=} \frac{20}{32}$ true

Check:

$5 \times 32 \stackrel{?}{=} 8 \times 20$

$160 = 160$

(c) $\frac{6}{16} \stackrel{?}{=} \frac{20}{48}$ ________

Check:

$6 \times$ ___ $\stackrel{?}{=}$ ___ $\times$ ___

___ $=$ ___

(d) $\frac{15}{3} \stackrel{?}{=} \frac{60}{12}$ ________

Check:

___ $\times$ ___ $\stackrel{?}{=}$ ___ $\times$ ___

___ $=$ ___

1. Finding a Missing Value in a Proportion

We can apply cross products to find a missing value in a proportion. We use a variable (such as a letter) to hold the place of the missing number.

EXAMPLE: Find the missing number in the following proportion.

$$\frac{2}{5} = \frac{n}{20}$$

"n" is the variable that replaces the missing number.

Solution:

$$\frac{2}{5} = \frac{n}{20}$$

$$5 \times n = 2 \times 20$$

$$5n = 40$$

Now we divide both sides by the number that multiplies the variable (which is 5).

$$\frac{\cancel{5}n}{\cancel{5}} = \frac{40}{5}$$

$$1 \times n = 8$$

$$\boxed{n = 8}$$

Now we must check to see if our value for n is correct.

Check:

$$\frac{2}{5} \stackrel{?}{=} \frac{8}{20}$$

← **We substitute the value for "n" in the place which "n" held in the proportion.**

$$2 \times 20 = 5 \times 8$$

$$40 = 40$$

The cross products are the same so 8 is the missing number.

Self-Correcting Exercise #3

Find the missing number in each proportion, then check your answer. Show all the steps. Answers are found on page 12 of this lesson.

1. $\frac{n}{6} = \frac{8}{24}$

$n \times 24 = 6 \times 8$

$24n = 48$

$\frac{24n}{24} = \frac{48}{24}$

n = _____

Check:

$\frac{\_\_\_}{6} \stackrel{?}{=} \frac{8}{24}$

___ $\times 24 = 6 \times 8$

_____ = _____

2. $\frac{1}{16} = \frac{5}{n}$

$1 \times n =$ 5 $\times$ 16

1n = _____

Check:

3. $\frac{4}{n} = \frac{12}{15}$

Check:

4. $\frac{45}{n} = \frac{21}{7}$

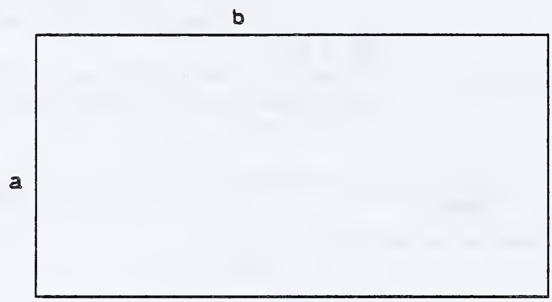
Check:

Scale Drawings

1. Drawing to Scale

Often it is necessary to use a smaller scale in showing a large physical object. This allows us to study a large area more conveniently. Examples of this kind of representation are road maps, house plans, diagrams of football plays, blueprints, etc. All of these can be related to the real object by a scale. For example, on a house plan one centimetre on the drawing may represent one-half of a metre in the house. We use proportions to translate from the drawing to the real-life object or from the real object to the drawing.

EXAMPLE:



1. The above diagram is a scale drawing of the exterior walls of a building. In this case, a length of one centimetre in the drawing represents a distance of 0.5 m in the building.

   The proportion would be:

$$\frac{1\text{ cm}}{0.5\text{ m}} = \frac{\text{number of cm in scale drawing}}{\text{number of m in building}}$$

2. How long is the wall represented by side "a"?

   The proportion is:

$$\frac{1\text{ cm}}{0.5\text{ m}} = \frac{\text{length of "side a" in cm}}{\text{length of "wall a" in m}}$$

   Measure "side a" above; a = ______ cm.

$$\frac{1}{0.5} = \frac{4}{A}$$

   where A represents the number of metres in the length of "wall a"

$$A = 4 \times 0.5$$

$$= \_\_\_\_\_\_$$

   The wall represented by "side a" is ______ m long.

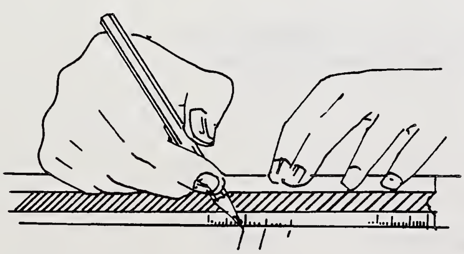
Self-Correcting Exercise #4

Complete the following chart:

Given Scale	Scale in Like Units	Representative Ratio with Numerator of 1	No. of Times Real Object is Larger than Scale Diagram
1. 1 cm = 1 m	1 cm to 100 cm	$\frac{1}{100}$	100 times
2. 1 cm = 1.5 m	1 cm to ____ cm		
3. 1 cm = 0.75 m			
4. 1 cm = 0.5 m			
5. 0.5 cm = 1 m	0.5 cm to ____ cm	$\frac{0.5 \times 2}{100 \times 2} =$ ______	
6. 0.5 cm = 5 m			

Check your answers with those on page 12 of this lesson.

Proper Use of the Triangular Scale



Note that the scale is applied directly to the paper.

Never use dividers to transfer from scale to paper.

ANSWERS TO SELF-CORRECTING EXERCISES

Self-Correcting Exercise #1, page 6

1. $\frac{61}{68}$, denominator is 68

2. $\frac{650}{420}$, $\frac{420}{650}$

3. $\frac{5}{32}$

4. $\frac{40}{16} = \frac{5}{2}$

Self-Correcting Exercise #2, page 8

(c) false

(d) true

Self-Correcting Exercise #3, page 9

1. $n = 2$

2. $n = 80$

3. $n = 5$

4. $n = 15$

Self-Correcting Exercise #4, page 11

2. 150 cm, $\frac{1}{150}$, 150 times

3. 75 cm, $\frac{1}{75}$, 75 times

4. 50 cm, $\frac{1}{50}$, 50 times

5. 100 cm, $\frac{1}{200}$, 200 times

6. 500 cm, $\frac{1}{1000}$, 1000 times

EXERCISES TO BE SENT IN FOR CORRECTION

EXERICSE 1: Scale Drawings

1. Measure "side b" in the scale drawing on page 10 and using a proportion, find the length of the wall represented by "side b."

   b = __________ cm

   Let B represent the number of metres in the length of wall b.

   $$\frac{1}{0.5} = \frac{\_\_\_\_}{B}$$

   B = 0.5 × __________

   B = __________

   The wall represented by "side b" is __________ m long.

2. The scale of a drawing is the ratio of any line of the drawing to the corresponding line of the object. In our given scale, 1 cm represents 0.5 m which is equal to 50 cm, so the scale can be written as a fraction $\frac{1}{50}$ or by means of a colon as 1:50. This ratio, called the **representative ratio**, is the simplified ratio of the scale. It tells how many times the real object size is larger than the scale diagram size.

   (a) The actual length of the building is __________ times as large as the corresponding length in the scale diagram.

   (b) A scale such as 1 cm = 3 m may also be written as 1 cm = ________ cm (since 3 m = 300 cm). Since 1 cm represents 300 cm, the scale can be written as the fraction —— or by means of a colon as ________ .

   The actual length of an object will be ________ times as large as the corresponding length in the scale diagram.

3. "Working" drawings for furniture use a scale of 1 cm to 10 cm. Using this scale, find the dimensions of the drawing of a table top 0.9 m wide and 1.8 m long.

   (a) Let W represent the width in cm in the "working" drawing. Convert 0.9 m to 90 cm (1 m = 100 cm).

   $$\frac{1}{10} = \frac{W}{90}$$

   The width of the table in the "working" drawing is ________ cm.

   (b) Now set up the proportion that applies for the length of the table and find the dimension used for the length in the "working" drawing.

   Let T represent the length in cm in the "working" drawing.

   Convert 1.8 m to ________ cm.

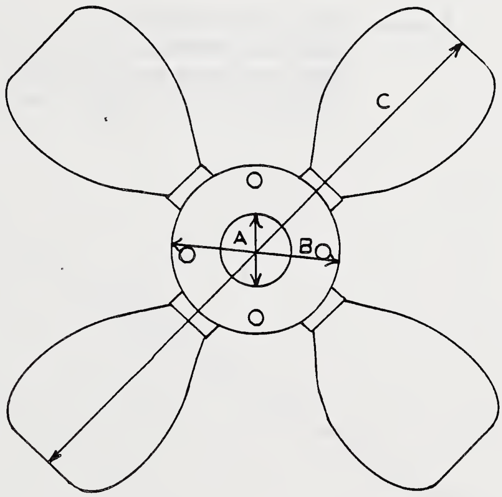
   $$\frac{1}{10} = \frac{T}{}$$

   The length of the table in the "working" drawing is ________ cm.

EXERCISE 2: More Scale Drawings

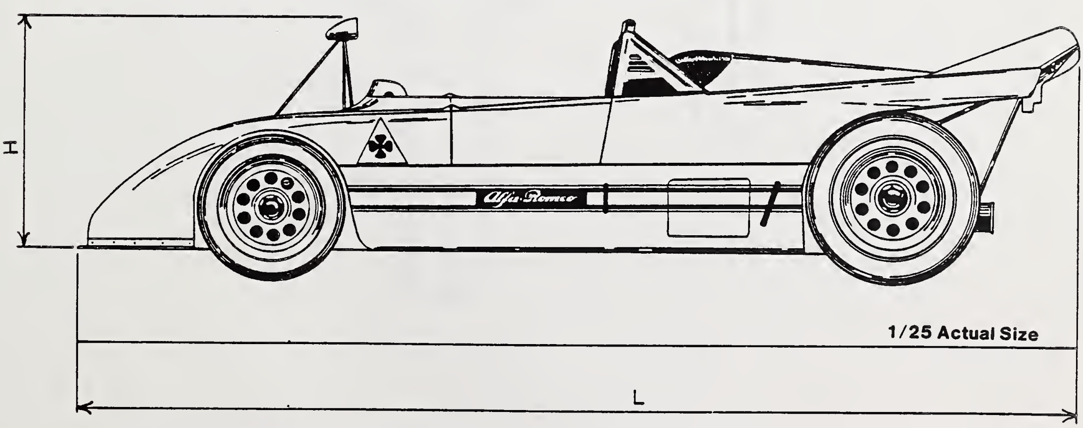
1. In making the basic plans for an automobile, a European firm made scale drawings of all the parts to be manufactured. Below is shown the scale drawing of a fan. Using the indicated scale, calculate the actual dimensions (in centimetres) of the lengths marked on the fan.

SCALE
10 mm represents 10 cm



A = ____________ B = ____________ C = ____________

2. Consider the scale drawing of the vehicle shown below.



1/25 Actual Size

The actual length (L) of the car is __________ metres.

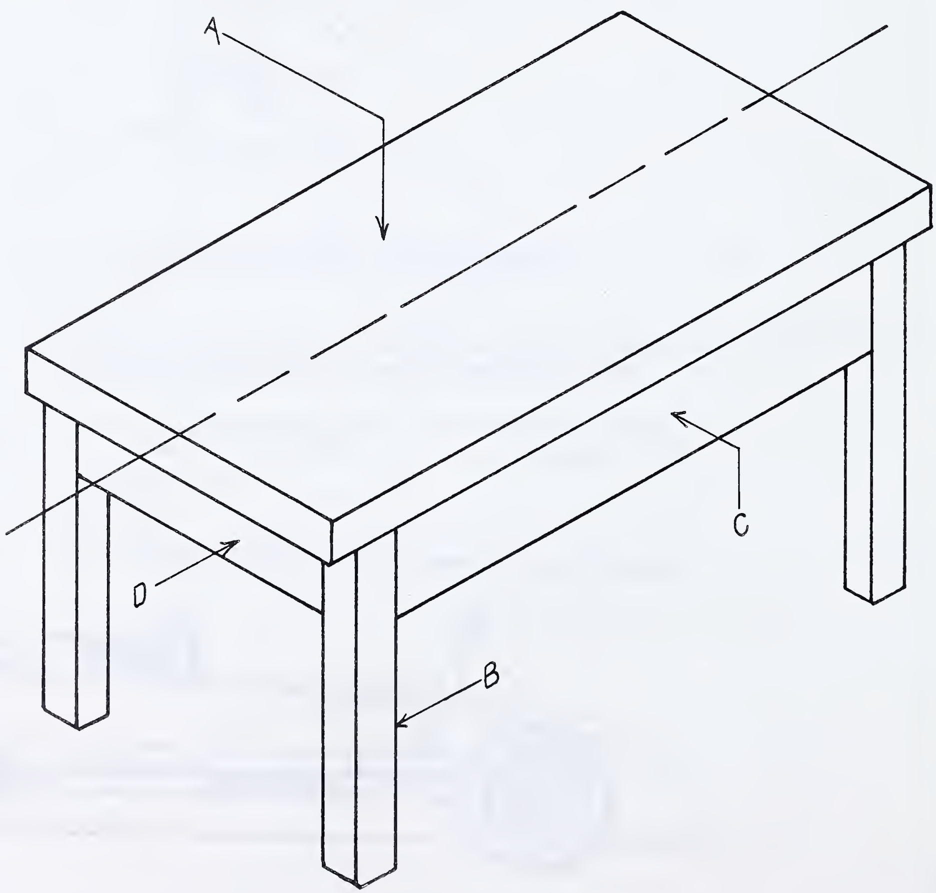
The actual height (H) of the car is __________ metres.

3. On a prepared plate, draw an orthographic **scale drawing** of this table. Pick a scale that will allow the drawing to fit easily on the plate. (Hint: Try a 1:15 scale.)

Part A is	130 cm long	× 70 cm wide	× 5 cm thick.
Part B is	80 cm	× 7.5 cm	× 7.5 cm.
Part C is	100 cm	× 10 cm	× 2 cm.
Part D is	40 cm	× 10 cm	× 2 cm.

The table is symmetrical.

Please: Show all hidden lines.
Show all necessary dimensions.
State the scale you are using.
Enclose all your rough drawings.



END OF LESSON 17

LESSON RECORD FORM

1715 DRAFTING 10

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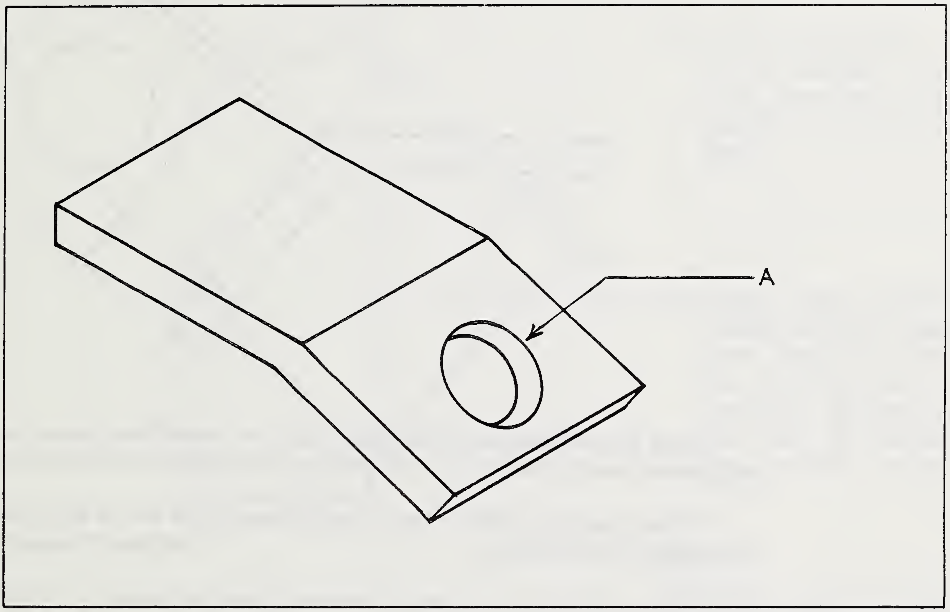
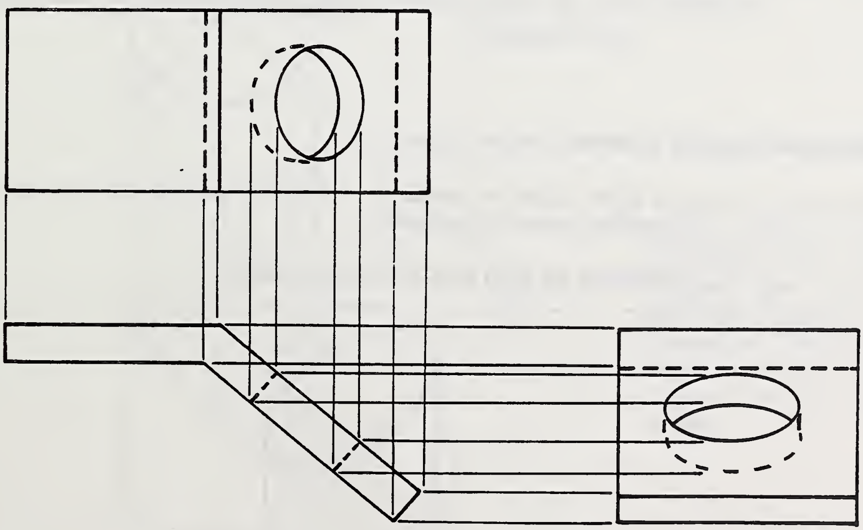
AUXILIARY VIEWS

Many machine parts have surfaces that are sloping or inclined. If ordinary orthographic projection is used to show these inclined surfaces, the view of the surface is distorted. Consider the following example.

BRACKET

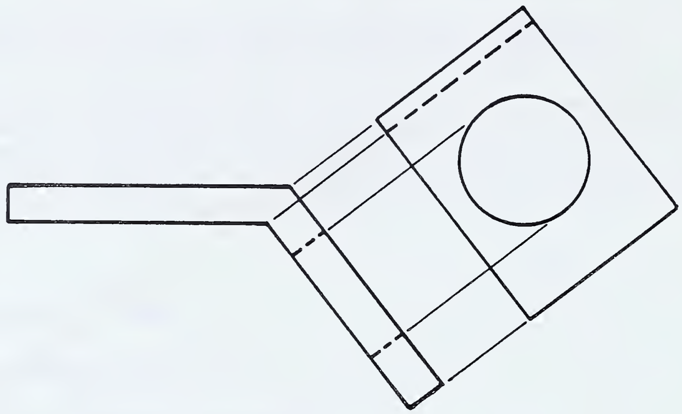


We have a bracket with sloping surface "A" and this surface has a ROUND hole in it. If we draw a standard orthographic 3-view drawing we get the following:



Notice that the ROUND hole appears egg-shaped in the views. It does not look round. Its appearance has become distorted.

To show the true shape of the inclined surface we employ a device known as an auxiliary view. The illustration below shows how an auxiliary view is placed.



Using the auxiliary view you can see that the round hole appears as a circle and is not egg-shaped (oval). Also the entire sloping surface is shown in its true proportion.

When drawing auxiliary views, the following hints are of help, and should be known thoroughly by the student.

1. The auxiliary view is always projected from the regular view on which the inclined surface appears as a line.

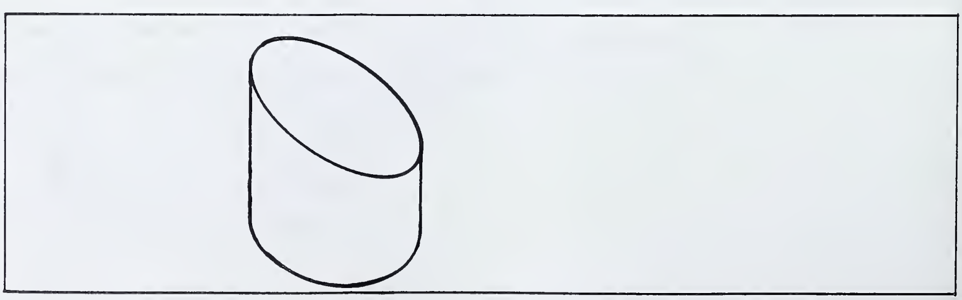
2. The projection lines from the inclined surface are always at right angles to the cut.

3. Only the inclined portion of the object is shown in the auxiliary view. The rest of the object is ignored.

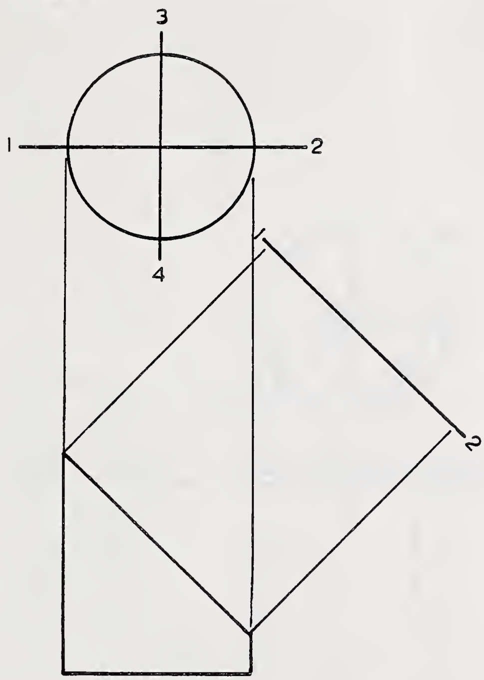
Drawing an Auxiliary View for a Round Object

If the object is circular (or something similar) in cross-section follow these steps. An example is given with each step.

A CIRCULAR ROD SLICED AT AN ANGLE



Steps (a), (b) and (c)

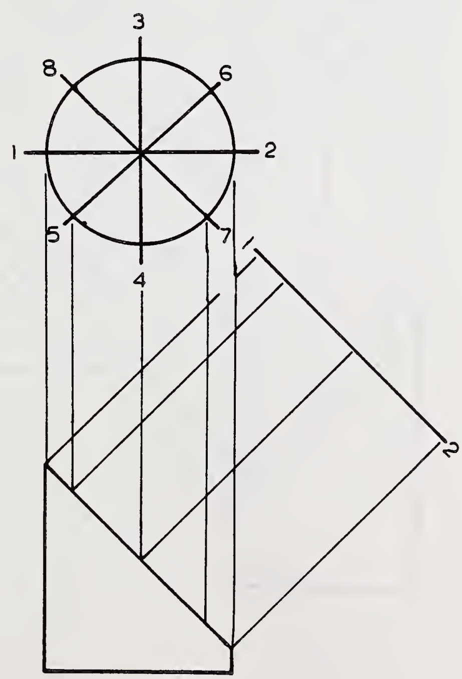


(a) Draw the normal orthographic views.

(b) Draw a centre line 1 - 2 for the auxiliary view. Make sure that it is parallel to the inclined face.

(c) Divide the circular section into four equal parts. Make sure that the horizontal line is perfectly horizontal and that the vertical line is perfectly vertical.

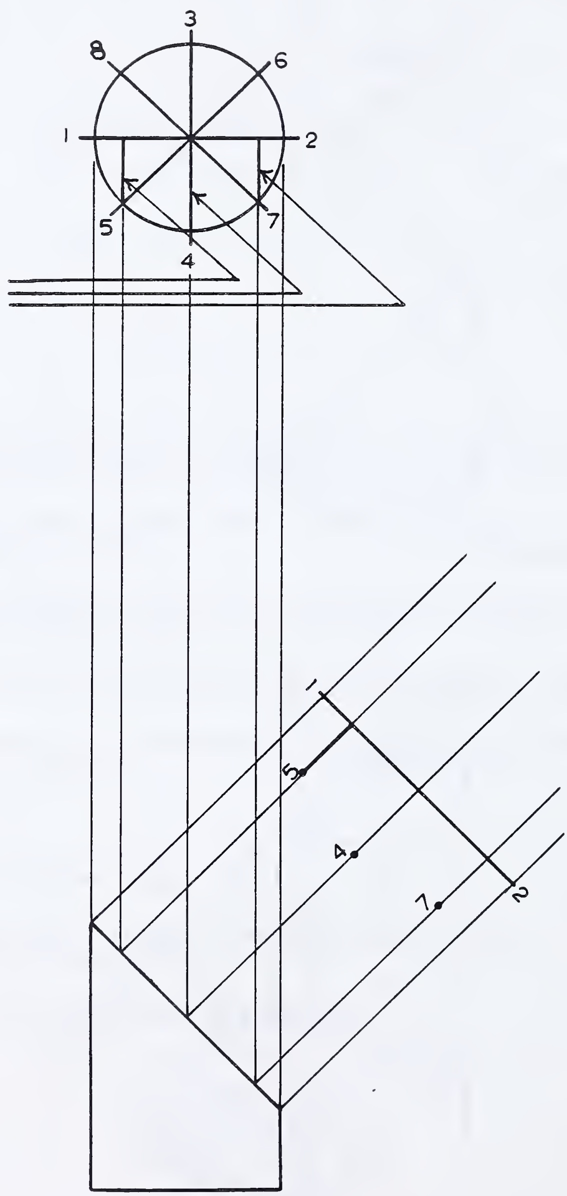
Steps (d) and (e)



(d) Divide the circular section into more parts. If the section is a perfect circle, then divide the circle into equal parts.

(e) Project the lower half of the circle onto the sloping face and "bounce" the lines so that they intersect the centre line. (Make sure they intersect the centre line at right angles.)

Step (f)



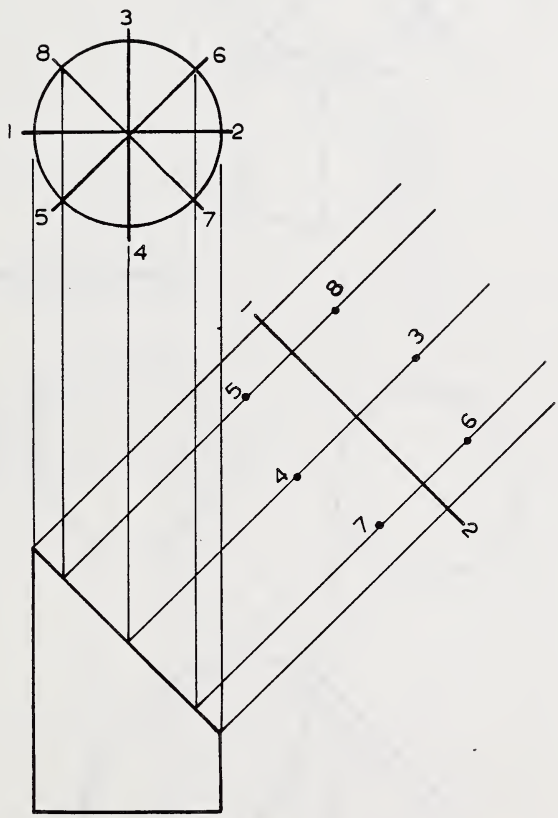
Measure these vertical distances.
Use a pair of dividers.

(f) On the top view, measure down from the line 1 - 2 to the points on the circle where the dividing lines cross.

Step (g)

(g) Transfer these measurements to the auxiliary view. Use a pair of dividers.

Steps (h), (i) and (j)

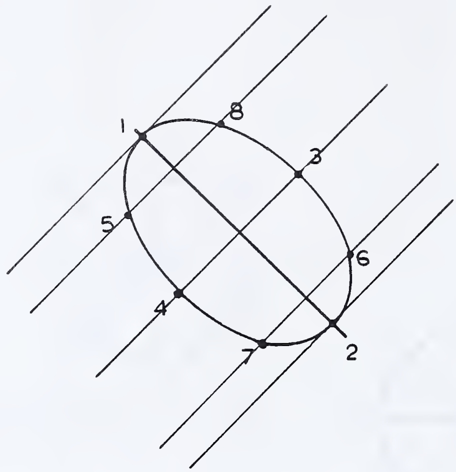


(h) Project the upper half of the circle onto the sloping face and "bounce" the lines so that they intersect the centre line.

(i) On the top view, measure up from line 1 - 2 to the points on the circle where the dividing lines cross.

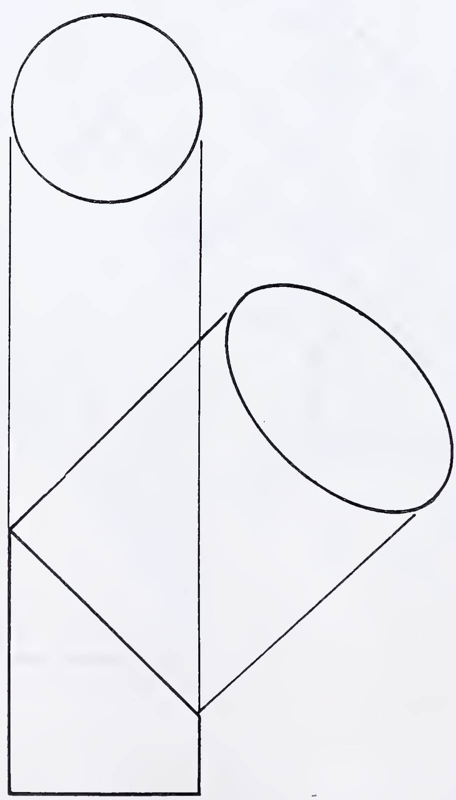
(j) Transfer these measurements to the auxiliary view.

Step (k)



(k) Join the points using a french curve.

Step (l)

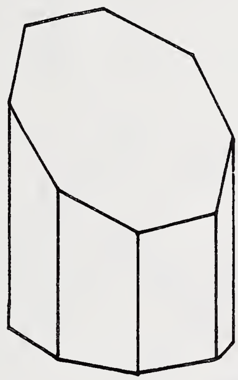


(l) You now have the completed auxiliary view.

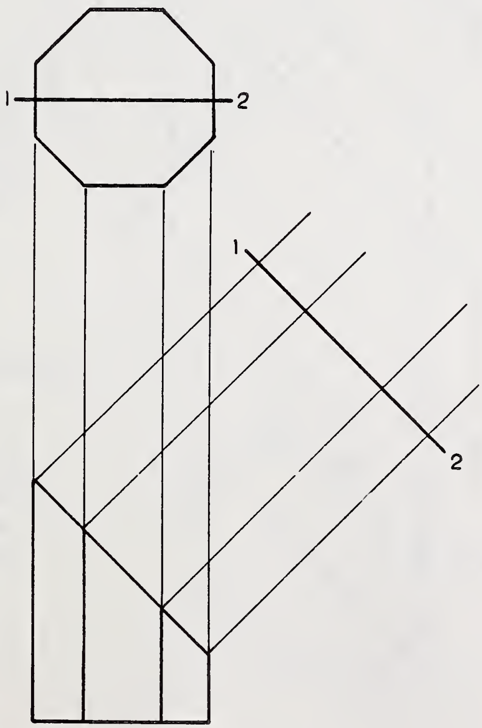
Drawing an Auxiliary View for a Polygonal Object

If the object is polygonal in cross section, a similar procedure is used, but with a modification. Consider the following example.

AN OCTAGONAL ROD SLICED AT AN ANGLE



Steps (a), (b) and (c)



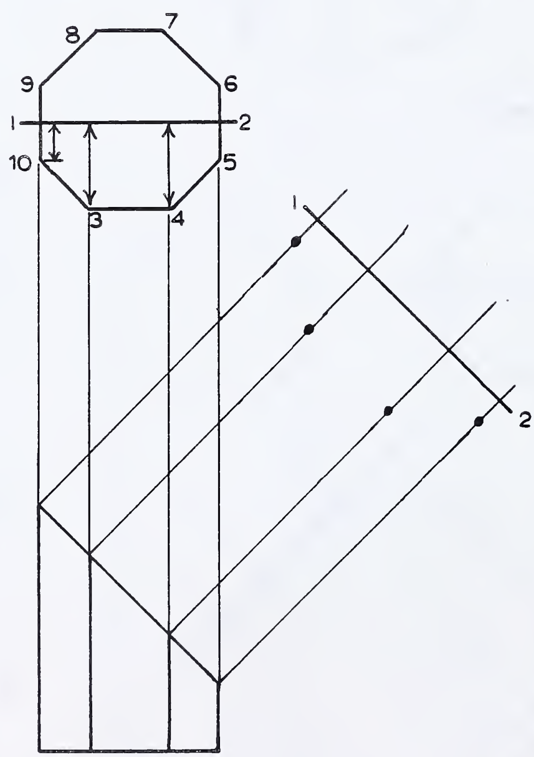
(a) Draw the normal orthographic views.

(b) Draw a centre line 1 - 2 for the auxiliary view.

(c) Divide the polygonal section into two parts by means of a horizontal line 1 - 2 as shown. Make sure the line is perfectly horizontal.

Steps (d), (e) and (f)

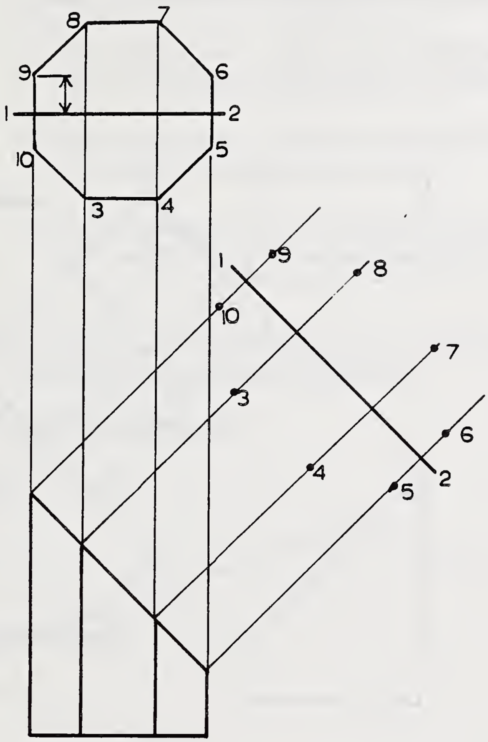
(d) Project the lower half of the polygon onto the sloping face and "bounce" the lines so that they intersect the centre line. It is a good idea to number the corners of the polygon so you do not get the corners confused.



(e) On the top view, measure down from the line 1 - 2 to each of the corners of the polygon.

(f) Transfer these measurements to the auxiliary view. Use a pair of dividers.

Steps (g), (h) and (i)

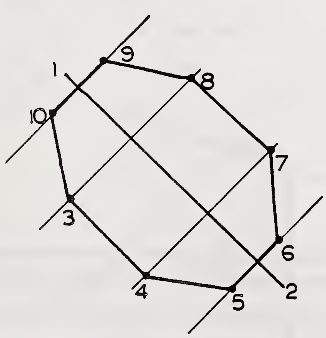


(g) Project the upper half of the circle onto the sloping surface and "bounce" the lines so that they intersect the centre line.

(h) On the top view, measure up from the line 1 - 2 to each of the corners of the polygon.

(f) Transfer these measurements to the auxiliary view.

Step (j)

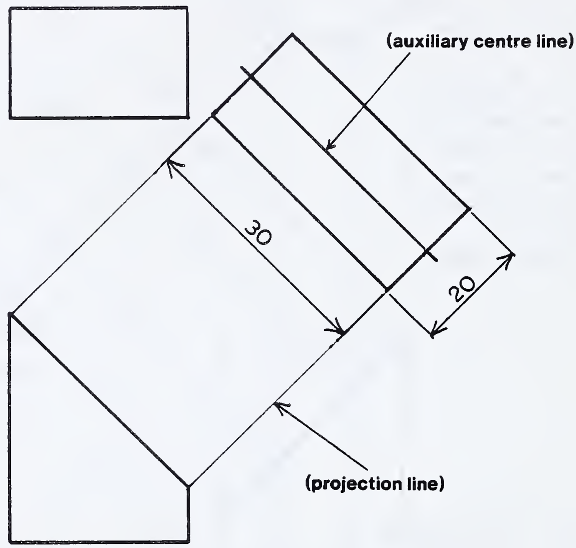


(j) Join the points with a straight edge, and your auxiliary view is now completed.

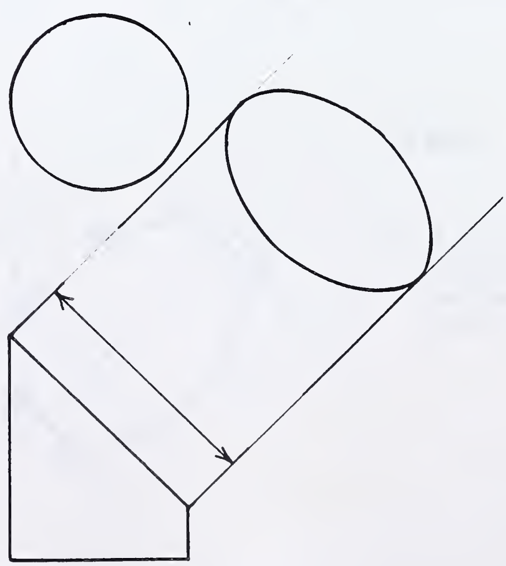
Dimensioning Auxiliary Views

Auxiliary views are dimensioned in the same manner as regular views. The dimension lines, however, are made either parallel to the auxiliary centre line or parallel to the projection lines. The diagrams below illustrate this point.

EXAMPLE 1



EXAMPLE 2



EXERCISES TO BE SENT IN FOR CORRECTION

EXERCISE 1: Inclined Surfaces and Auxiliary Views

1. Answer each of the following questions either **true** or **false**.

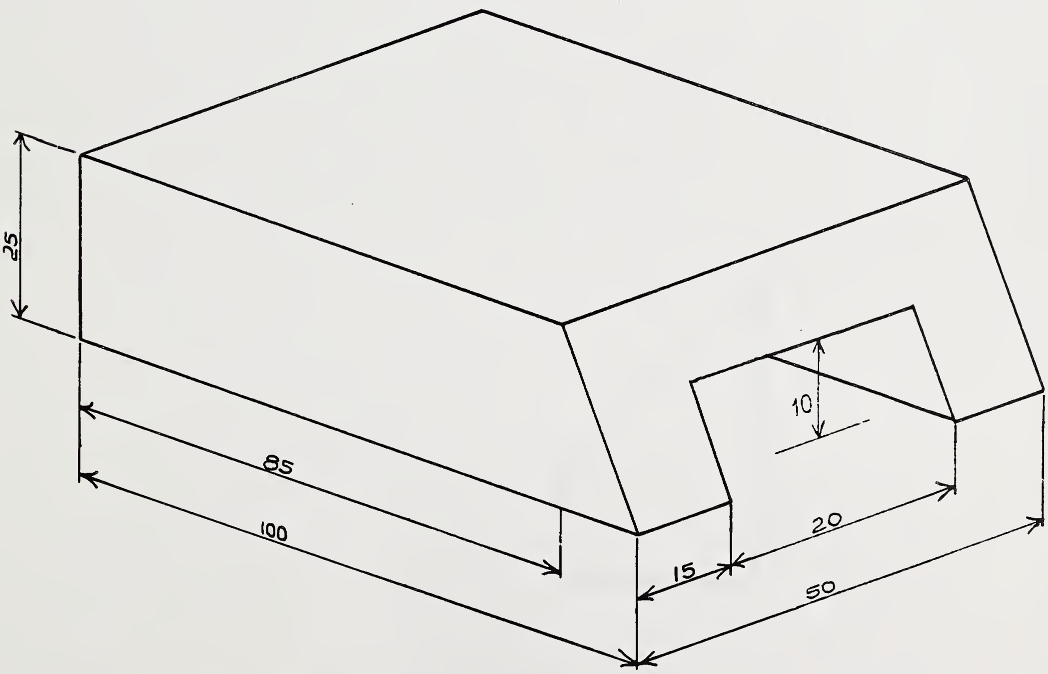
   (a) The auxiliary view is always projected from the regular view where the inclined surface appears as a line. ______________

   (b) The projection lines from the inclined surface are always at right angles to the cut. ______________

   (c) The inclined surface of the object is shown in the auxiliary view, and the rest of the object is also shown. ______________

2. On a separate prepared plate, draw an orthographic 3-view and an auxiliary view for the object below. Include all dimensions.

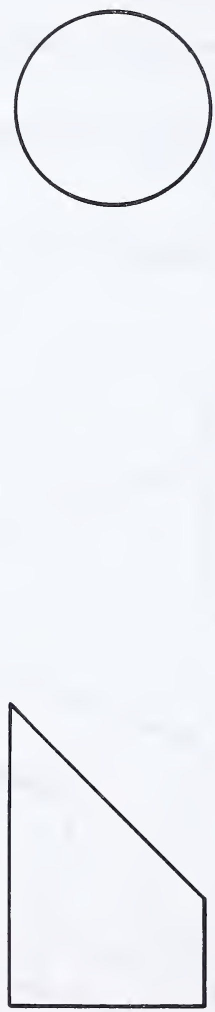
MACHINED CAST BLOCK



NOTE:	The bottom, the sloping face, and all three sides of the channel are finished.
	The channel goes all the way through the length of the block.
	All sides of the channel are 15 mm thick.
	Drawing is not to scale.

EXERCISE 2: Auxiliary View

Add an auxiliary view to the orthographic drawing shown below. No separate plate is required. You can draw it on this sheet in the space below.



END OF LESSON 18

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1715 DRAFTING 10

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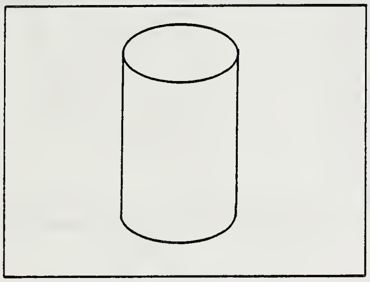
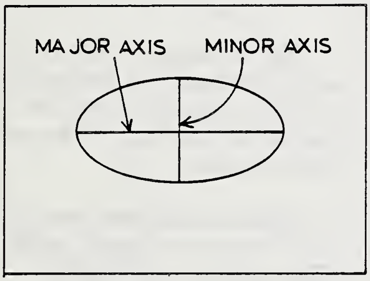
ISOMETRIC DRAWING: CIRCLES AND ARCS

The Circle as an Ellipse in an Isometrical Pictorial

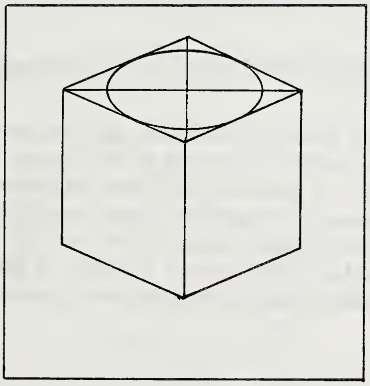


When a circle lies in a plane which is not perpendicular to the line of sight of the observer, it always appears as an ellipse. For instance, if a cylinder is held below eye level, the top and bottom are portrayed by curves which are ellipses or semi-ellipses.

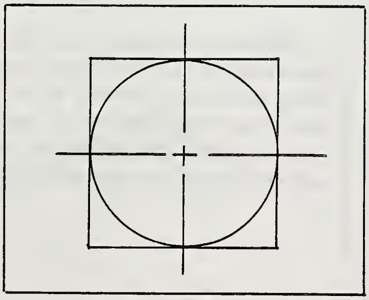


The precise definition of an ellipse need not concern us here. Notice however, that if the shortest and longest diameters are drawn across the ellipse, the curve is divided into four segments which are exactly the same shape and size. The diameters are called the major and the minor axes and the ellipse is symmetrical about both axes.

1. Top View

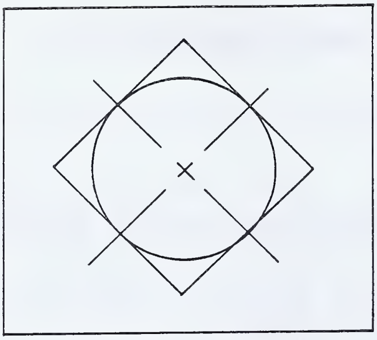


Now consider a circle on the top face of a cube in an isometric drawing. The circle will show as an ellipse and the major and minor axes will be along the diagonals of the isometric square.



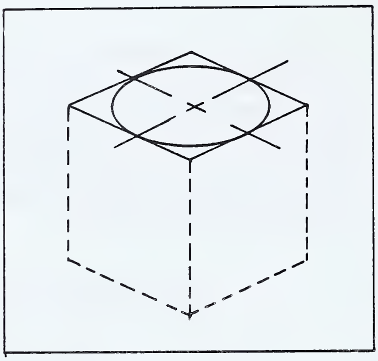
Top view in orthographic projection

Consider the top view of the box when it is drawn in orthographic projection.



Top view revolved through 45°

If the top view is revolved through 45° it takes up the position in which it appears in the isometric picture. Notice that the centre lines of the circle pass through the midpoints of the edges of the cube.

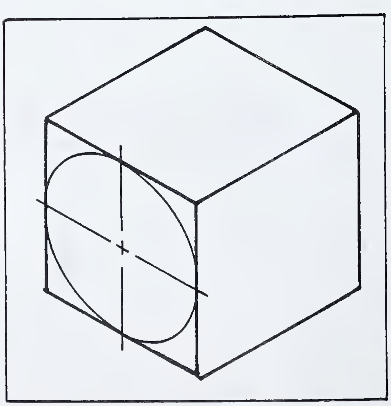


In the isometric picture the angles between the sides are changed to the familiar 60°, 120° diamond, but notice that the centre lines of the circle remain parallel to the edges of the cube and pass through their midpoints.

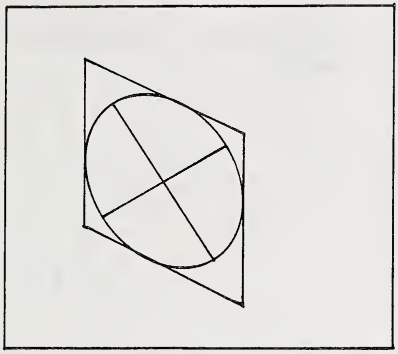
Note that the true length of the diameter of the circle equals the length of the edges of the cube. (The minor axis of the ellipse is shorter and the major axis is longer than the diameter of the circle which the ellipse represents in isometric.)

A true ellipse cannot be drawn by means of compasses, but an approximate ellipse can be drawn by using arcs of two different radii which meet at their points of tangency. Such an ellipse serves very well to represent a circle in isometric projection. For the practical draftsperson ellipse guides or templates are available. These consist of plastic sheets within which a variety of ellipses of differing shapes and sizes are cut out. The user selects the ellipse required, inserts a pencil and moves it around the edge of the ellipse as with any stencil tracing. The guides are available at drafting dealers under the name **RapiDesign**.

2. Side View

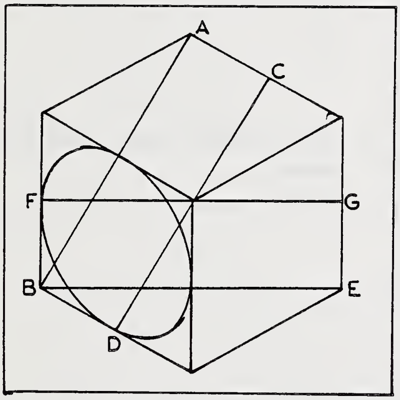


When a circle is on the side of an isometric box, it again appears as an ellipse, because the line of sight along which it is viewed is not perpendicular to the plane containing the circle. Again, the centre lines of the circle are parallel to the edges of the cube and pass through the midpoints of the edges.



Note however, that the major and minor axes of the ellipse are NOT parallel to either of the isometric axes of the plane in which it lies. The ellipse is "tipped" so that the major axis is at 60° with the horizontal.

The centre lines of the circle ARE parallel to the isometric axes so the true diameter of the circle can be measured along its centre lines.

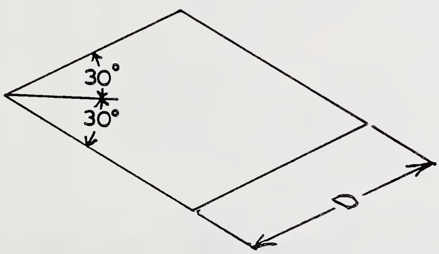


The ellipse may be drawn with compasses by the two radii method. If the complete isometric cube is drawn, the midpoints of the sides can be located by lines joining corners of the cube like this:

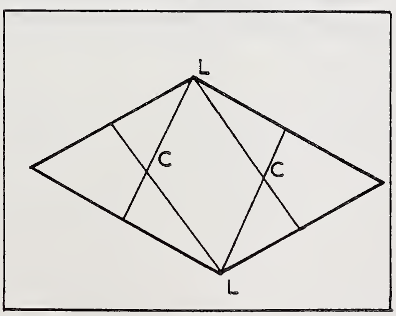
Draw CD parallel to AB at 60° with the horizontal;

Draw FG parallel to BE (horizontal).

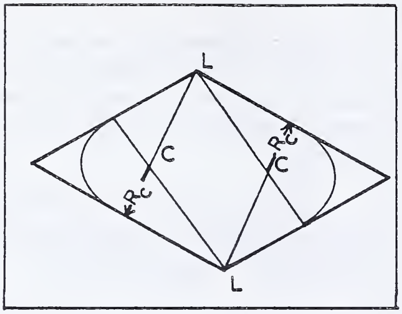
How to Draw an "Isometric Circle" or Appoximate Ellipse Using Compasses



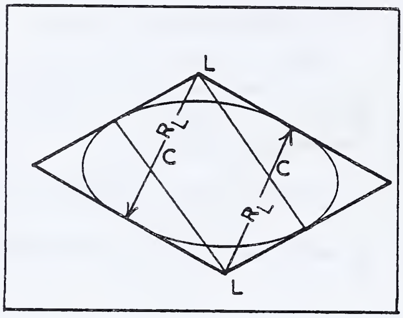
1. Construct a face of the isometric cube. If the diameter of the circle is D mm, then the side of the cube is also D mm.



2. Draw lines from the two 120°-corners, LL, of the "diamond" face to the midpoints of the opposite sides. You can use your 30°-60° triangle for this. Let these lines cross at CC.

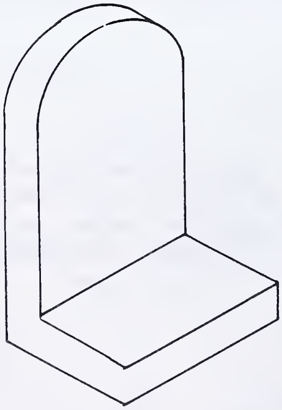


3. With centres C and C draw arcs of radius R_C as shown.

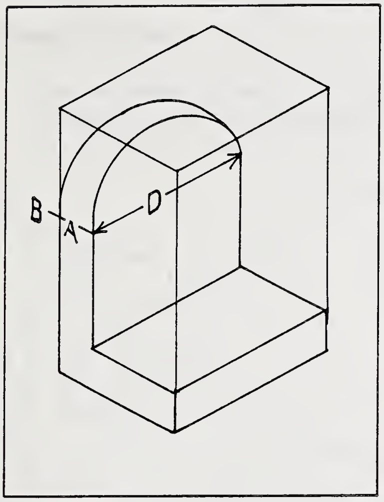


4. With centres L and L draw arcs of radius R_L as shown.

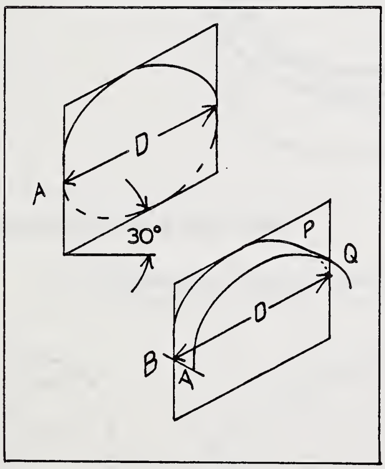
Sketching in Isometric



The top edge of the bracket in this isometric pictorial sketch is the arc of a circle. In fact, it is a semicircle. Each arc becomes a portion of an ellipse (a semi-ellipse) in the isometric view.



The general shape of the object conforms to an isometric box as shown in the drawing. Note that the true diameter of the arcs is along the centre line as shown.

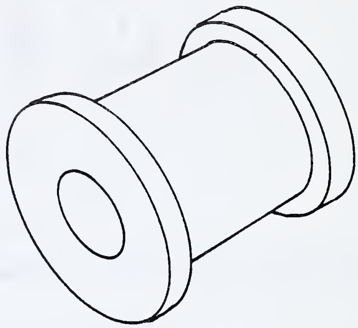


To locate the arc of the ellipse we should have to consider the ellipse, enclosed in the "diamond" as shown to the left.

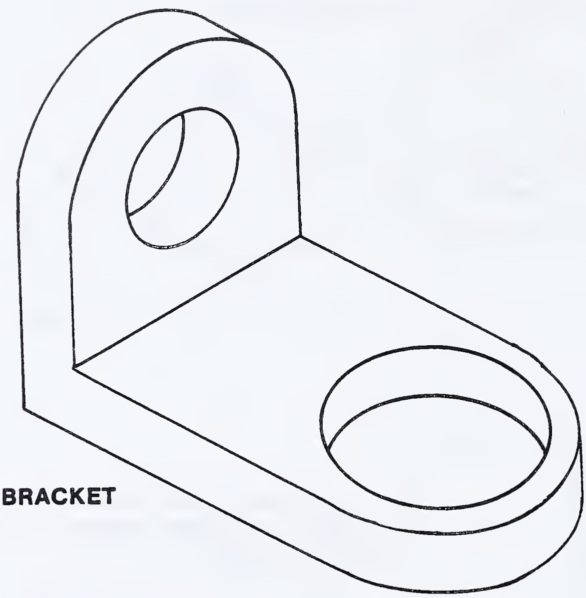
Thus, to draw the arc, make a diamond of side equal to the diameter of the arc. Place it so that the midpoint of the left side is at A. The arc can then be sketched free-hand (or drawn by the compass-two radii method).

A similar diamond at B locates the rear arc. PQ is a straight edge of length equal to the thickness of the bracket wall.

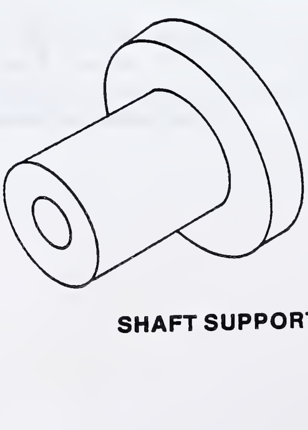
SOME EXAMPLES OF ISOMETRIC DRAWING: CIRCLES AND ARCS



ROLLER



BRACKET

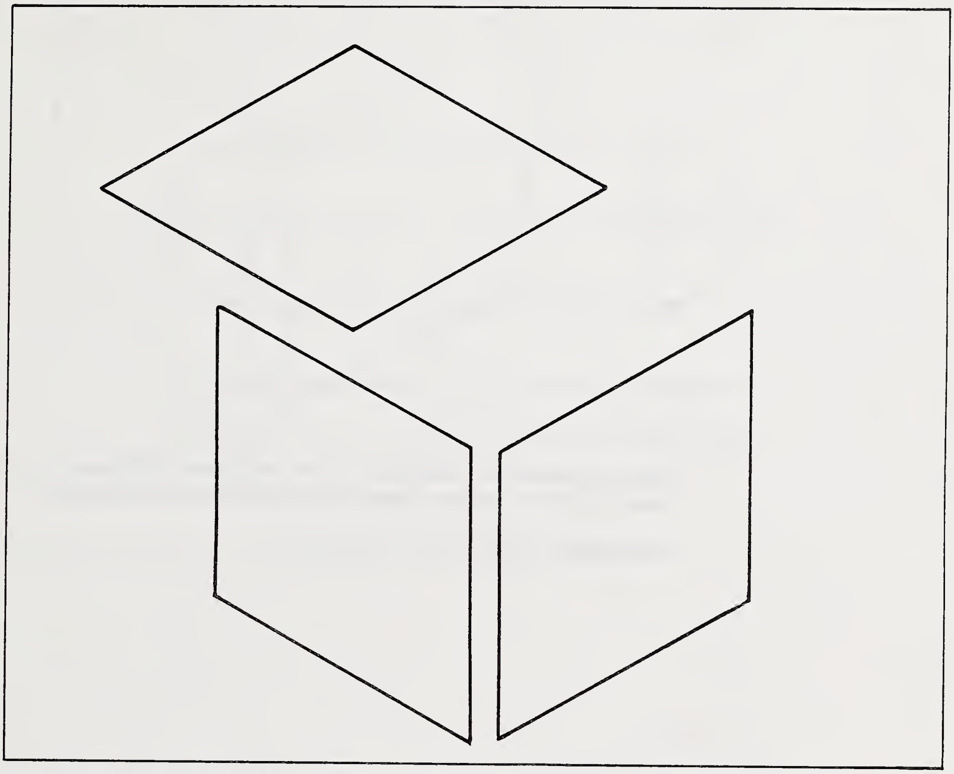


SHAFT SUPPORT

EXERCISES TO BE SENT IN FOR CORRECTION

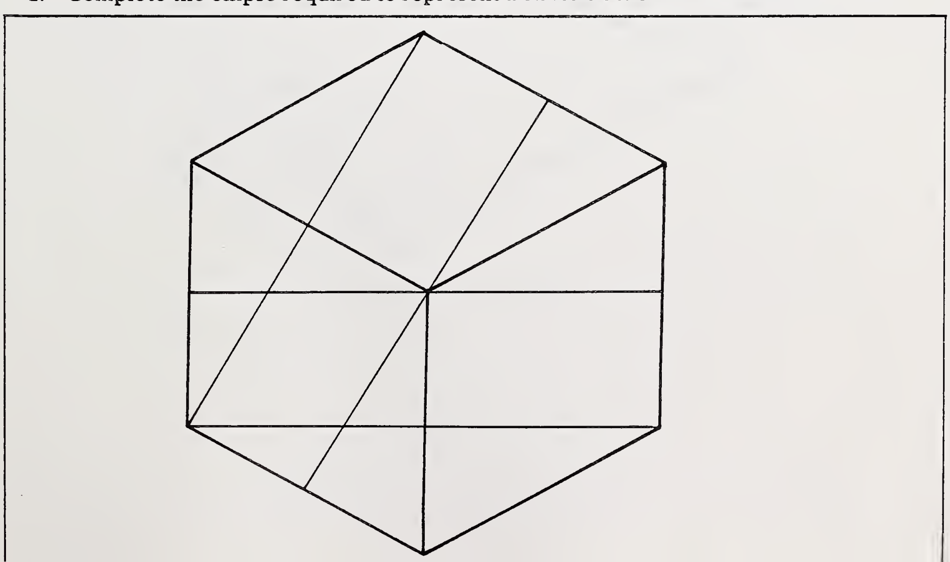
EXERCISE 1: Isometric Circles

Draw an ellipse in each of the faces of an isometric cube as shown below, by means of the compasses and two-radii method.

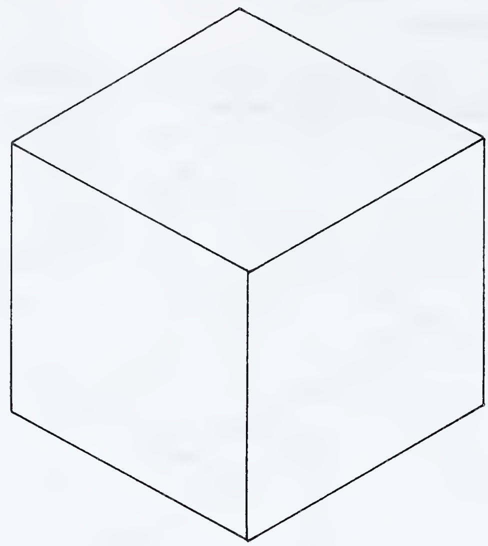


EXERCISE 2: Isometric Circles (side view)

1. Complete the ellipse required to represent a circle on the LEFT side of this cube.



2. Draw the lines required to bisect the edges of the RIGHT side of this cube.

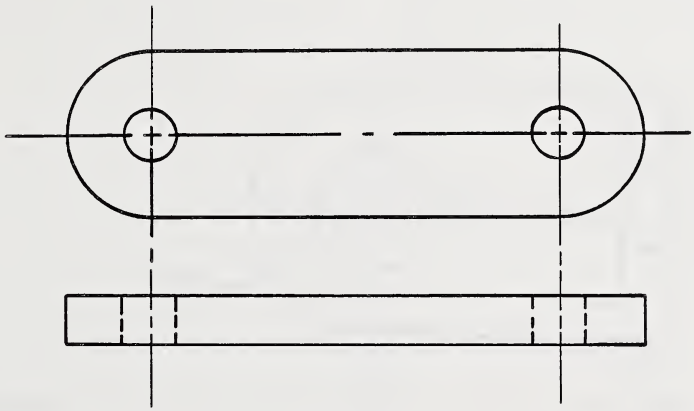


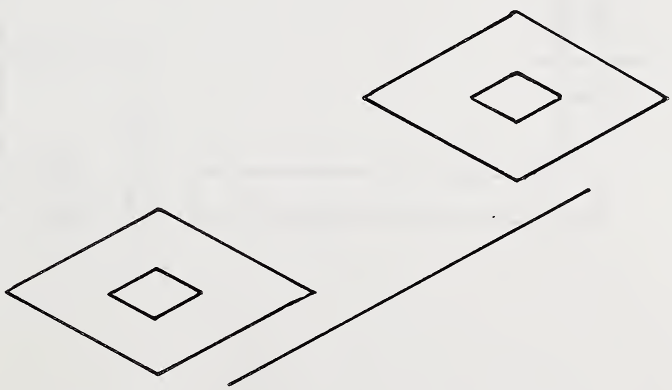
3. Make an isometric drawing of a cube with sides of 50 mm. Use the two-radii method to draw a circle in isometric projection on each face of the cube.

   How long is the diameter of the circle? ______________________

EXERCISE 3: Sketching an Isometric Pictorial Drawing

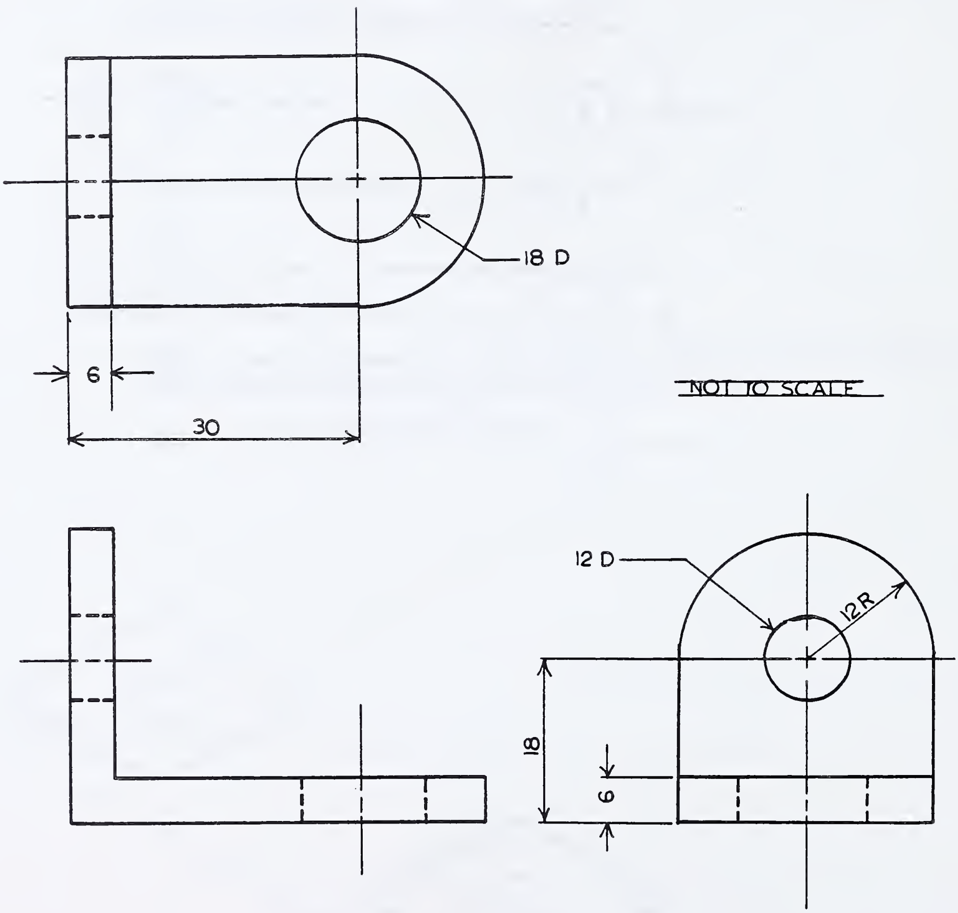
A two-view orthographic drawing of a connecting link is given below. Complete the isometric sketch of the link with the aid of the construction diamonds supplied.





EXERCISE 4: Isometric Drawing

Using the orthographic views of the object below, draw a double-size isometric drawing on a prepared plate. Use intruments and **leave in all construction lines**. (The top of your object should look very similar to the object on page 6.) Do not forget to consider the possibility that the bottom of the circle may also be visible. Dimension the object completely.



END OF LESSON 19

LESSON RECORD FORM

1715 DRAFTING 10

Revised 87/07

FOR STUDENT USE ONLY

Date Lesson Submitted

____

Time Spent on Lesson

____

(If label is missing or incorrect)

File Number

____

Lesson Number __________

FOR SCHOOL USE ONLY

Assigned Teacher: ________

Lesson Grading: ________

Additional Grading E/R/P Code: ________

Mark: ________

Graded by: ________

Assignment Code: ________

Date Lesson Received:

____

Lesson Recorded ______

Student's Questions and Comments

Apply Lesson Label Here

Name

Address

Postal Code

Please verify that preprinted label is for correct course and lesson.

Teacher's Comments:

____

Correspondence Teacher

St. Serv. 1-86

ALBERTA DISTANCE LEARNING CENTRE

MAILING INSTRUCTIONS FOR CORRESPONDENCE LESSONS

1. BEFORE MAILING YOUR LESSONS, PLEASE SEE THAT:

(1) All pages are numbered and in order, and no paper clips or staples are used.
(2) All exercises are completed. If not, explain why.
(3) Your work has been re-read to ensure accuracy in spelling and lesson details.
(4) The Lesson Record Form is filled out and the correct lesson label is attached.
(5) This mailing sheet is placed on the lesson.

2. POSTAGE REGULATIONS

Do not enclose letters with lessons.

Send all letters in a separate envelope.

3. POSTAGE RATES

First Class

Take your lesson to the Post Office and have it weighed. Attach sufficient postage and a green first-class sticker to the front of the envelope, and seal the envelope. Correspondence lessons will travel faster if first-class postage is used.

Try to mail each lesson as soon as it has been completed.

When you register for correspondence courses, you are expected to send lessons for correction regularly. Avoid sending more than two or three lessons in one subject at the same time.

REVIEW

In this lesson, a number of things which were taken during the year will be reviewed. It would be easy for you to look up the appropriate lessons in this course before doing each exercise, but if you do this, you would not really be finding out what you really know. You might like to pretend that this is a test, and give yourself about half an hour for each drawing. Only AFTER you have done everything you can, on your own, THEN look up the appropriate lessons for additional information.

EXERCISE 1: Block

Below, you are given a pictorial drawing of an object plus a front view. You are to recopy the front view, full size, on a properly prepared plate, and in addition, draw a top view and a LEFT side view. Properly place all necessary dimensions.

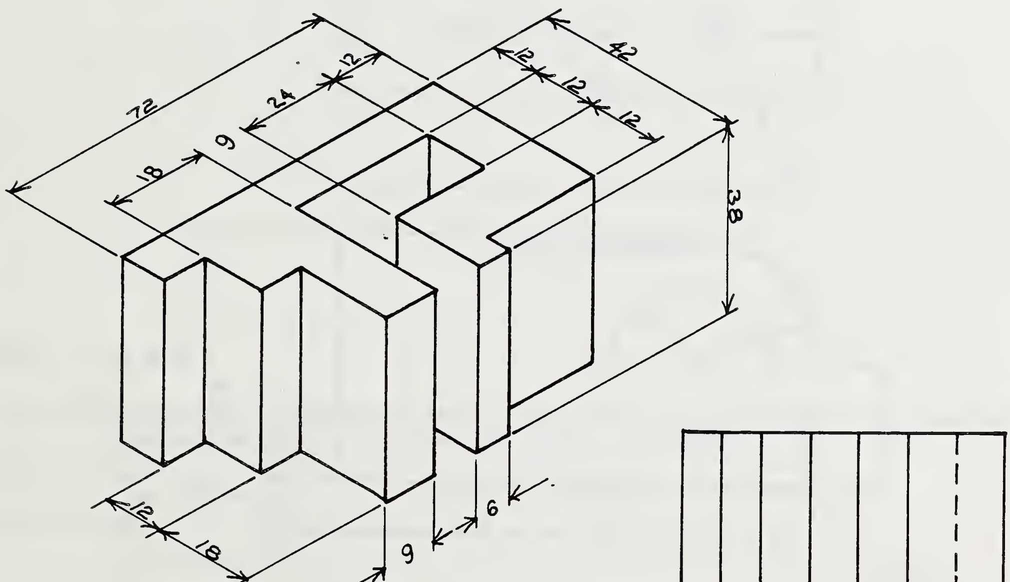


Figure 1: BLOCK

EXERCISE 2: Angle Stop

For the object shown in Figure 2 below, make an isometric drawing. Dimensions may be omitted.

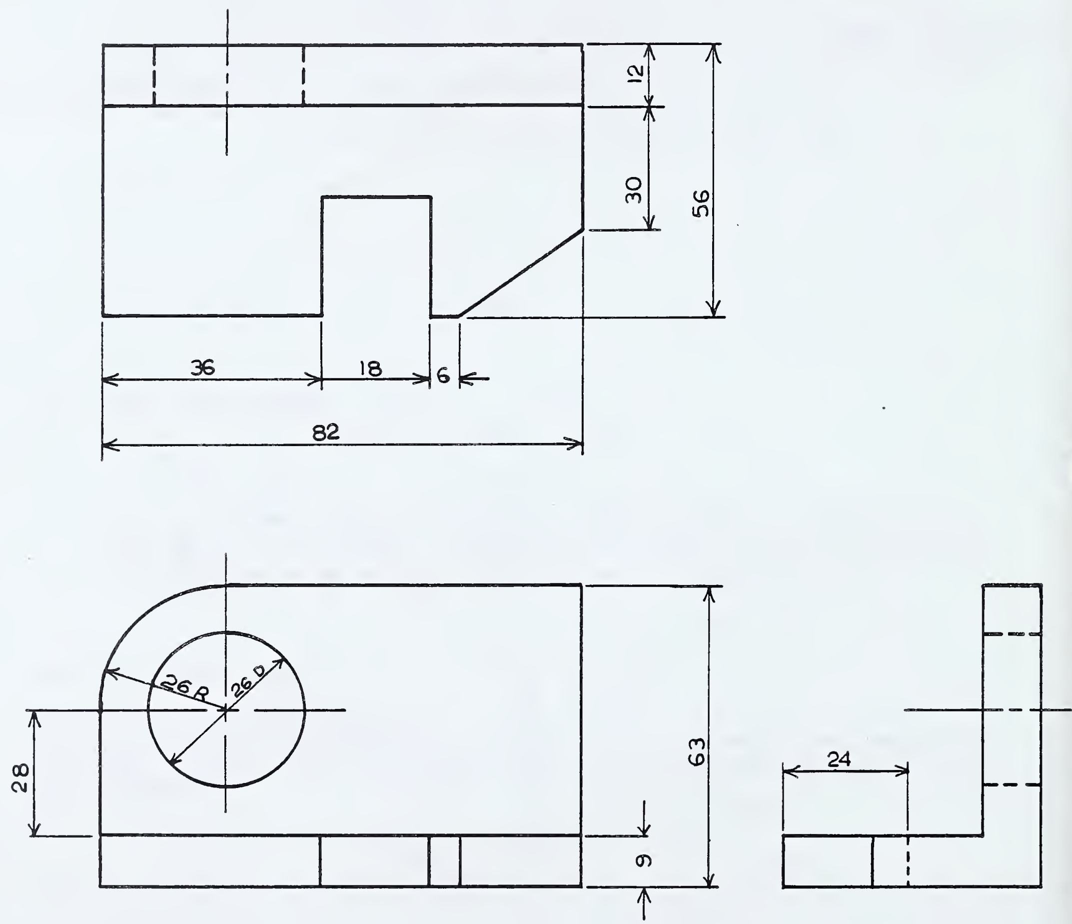


Figure 2: ANGLE STOP

EXERCISE 3: Pyramid

On a properly prepared plate, make a scale drawing of the two views of the pyramid shown below, and then make an auxiliary view. Leave in all construction lines. Be sure to use an appropriate scale.

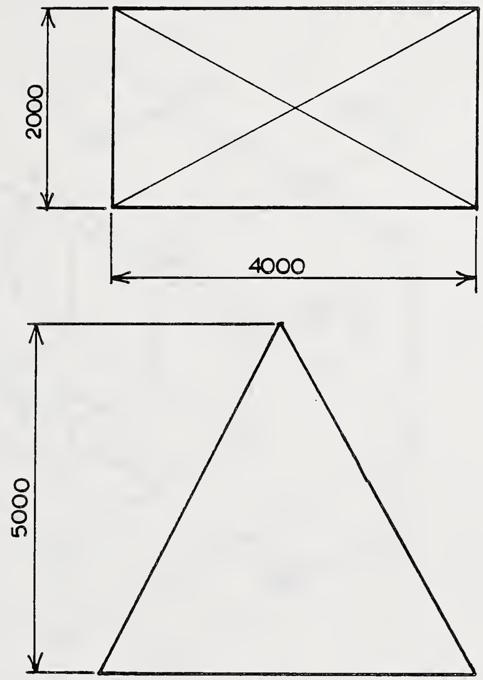


Figure 3: PYRAMID

EXERCISE 4: Cut Rod

On a properly prepared plate, make a drawing of the two views of the cut rod. Then, make an auxiliary view. Leave in all construction lines.

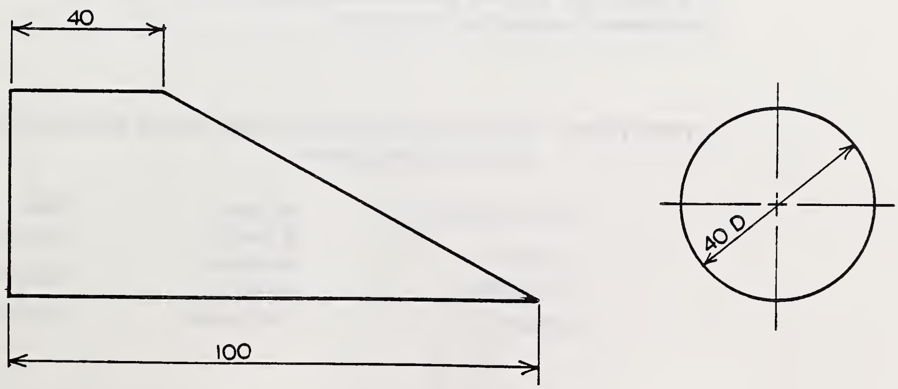


Figure 4: CUT ROD

EXERCISE 5: Slotted Block

Make a top view and full sectional front view of the block shown in Figure 5 below. Use instruments and put on all dimensions.

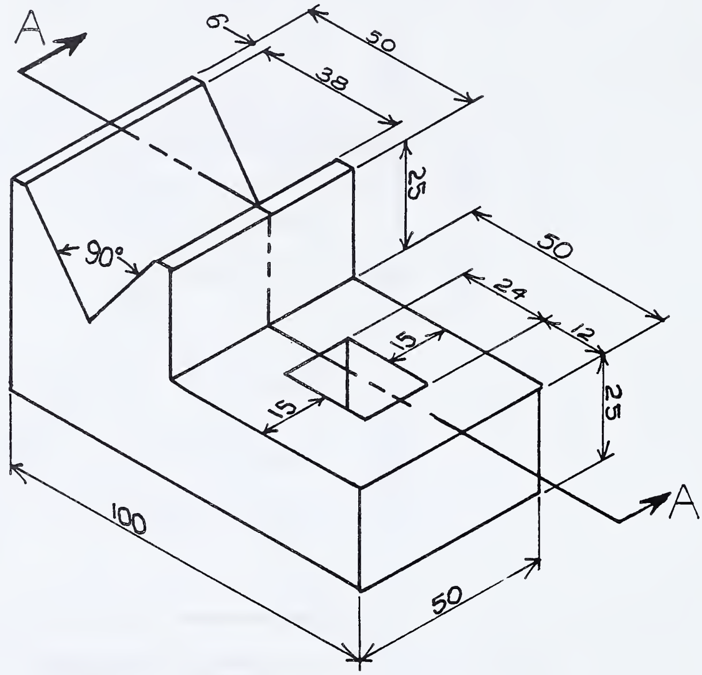


Figure 5: SLOTTED BLOCK

If you have enjoyed the work in this course and have had good gradings on your lessons, it is hoped that you will go on to more advanced work in drafting with a view to becoming a professional draftsperson or engineer.

ATTENTION! When you sit for the final test be sure to have access to the following at the examination room:

Drawing board	4H pencil	Scale
T square	H pencil Sandpaper	30°-60° triangle
Compasses	Eraser	45° triangle
Dividers	Dust brush	Drafting tape

END OF LESSON 20

COURSE EVALUATION QUESTIONNAIRE

Now that you have completed Lesson 12 (3-credit course), Lesson 16 (4-credit course), Lesson 20 (5-credit course), we would like you to do an evaluation of the Drafting 10 course. The comments made on this sheet will not have any effect on your final grade in the course. Please give sincere replies.

Include the questionnaire with your last lesson of this course.

1. What did you like about this course?

____

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2. What sections or parts of the course do you feel should be improved? Please indicate whether you did not understand the section as presented or whether you feel more in-depth information should have been presented.

____

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____

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3. What additional information or topics would you like to see covered in this course?

____

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____

4. In general, was the course presented to you at a level where you could understand the material or was it at a level which was way over your head? Please be specific if possible.

5. Did your teacher provide enough help (hints, comments, reference pages, etc.) so that you could correct any errors you had or improve answers which were only partly right?

6. Are there any other comments you would like to make?